THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, James T. Case, M.D., Battle Creek, Mich.

VOL. V (NEW SERIES) MARCH, 1918 No. 3

A BRIEF HISTORY OF THE DEVELOPMENT OF FOREIGN BODY LOCALIZATION BY MEANS OF THE *X*-RAYS

WITH BIBLIOGRAPHY

BY JAMES T. CASE, M.D., F.A.C.S.

Major, Medical Reserve Corps, U. S. A.; Director of Roentgenology for the American Forces, France

IN reviewing the methods of localizing foreign bodies, one is immediately impressed with the fact that the publications of the year *1896* set forth the principles at the foundation of most of the localizing methods of to-day. This year saw the publication of Buguet and Gascar, setting forth the classical formula

$$\text{Depth equals } \frac{b \times h}{a+b}$$

when a represents the distance the tube is shifted; b the distance of shift of the shadow of the projectile; and h the height of the screen or plate from the focus of the tube. Early in this same year Elihu Thompson in America, and Imbert and Bertin in France, proposed stereoscopy in connection with *x*-ray localization. The method of making two exposures at right angles, the so-called method of right angled planes, was proposed by White, Goodspeed and Lester Leonard.

1897.—This year marked the publications of Mackenzie Davidson and Hedley on the triangulation method, visualizing in space the position of the foreign body by means of crossed threads, and the method of Gerard and of Levy-Dorn which utilized the same principle of triangulation, but without the cross-thread visualization. Stechow wrote further on the method of making two exposures at right angles. Exner described a method combining a ring localizer with the triangulation principle, and later used the parallax principle. The parallax principle was also used by Levy-Dorn. Payne described a method similar to that of Mackenzie Davidson, and added a consideration of its application to mensuration of the pelvis. Wentzlik laid a small chain on the skin between two points marked with silver nitrate, and located a foreign body in relation to the links of the chain. Rémy and Contremoulins described an elaborate apparatus which was apparently the forerunner of the Hirtz compass as used to-day. Marie and Ribaut published their paper on precise stereoscopy, and Mackenzie Davidson successfully produced stereofluoroscopy for the first time. Mackenzie Davidson's achievement laid the foundation for a train of experimental work closely followed up by Caldwell of New York, which is now culminating in the production by Caldwell of a practical stereofluoroscope. Walsh published his method of visualizing the skin of the part

containing the foreign body by the application of a bismuth paste. He employed this method in a case of needle in the hand.

1898.—Caldwell brought out an apparatus consisting of two or more metal rods which were pointed at the ends, and held in a framework of wood or of aluminium in such a way that they could be placed on a photographic plate, resting exactly perpendicular to it. During the exposure of the plate these rods cast pointed shadows on the plate which made an angle with each other. By means of lines drawn through these shadows and certain calculations and measurements, the position of the foreign body could be accurately indicated.

The Dennis fluorometer, consisting of an upright grid or ladder attached to the table, was used frequently in the Spanish American War, where it was found to work rapidly and well, especially in screen localization. The Hall-Edwards "grid" was described this same year.

The parallax method was further described by Angerer and by Sehrwald.

The single tube shift and triangulation method first described by Buguet and Gascar was again set forth in papers by Harrison, Turner, Wagg, and Hedley; Mergier used the same method and the same formula, but, instead of shifting the one tube, used two tubes.

Morize used four small adhesive discs of lead: one he placed at the points on the skin where the vertical ray passing through the foreign body entered and left the part; the other two were placed in a similar manner at right angles (or nearly so) to the plane of the first two. The intersection of the two diameters joining these four points gives the location of the foreign body. The method of Araujo (Lima) was similar, though published a month later.

1899.—Galeazzi was apparently the first to publish a description of the "pierced screen," the ordinary fluoroscopic screen with a small hole drilled through it and the lead glass cover, sufficiently large for the insertion of a small rod for estimating the depth from the screen surface to the skin in those locations where it was not possible to bring the screen in actual contact with the party under study. He also employed the triangulation method with single tube shift, and added a direct-reading scale, obviating the necessity of calculations. The method described by Guilloz was similar to that of Mergier in 1898.

Sechehaye, in January of this year, published a review of the literature on the subject and was able to summarize thirty-two methods and authors; to which he added one new method, a complex mathematical procedure, employing a sort of grid, as previously mentioned for Hall-Edwards and Dennis.

Warluzel and Jollant, before the French Society for the Advancement of Science, described the use of malleable metal bands applied over the part as giving assistance in the localization of projectiles and other foreign bodies, the work of these authors thus considerably antedating later publications on this feature of localization methods.

Wildt called attention to the fact that foreign bodies move with passive motions of the tendons in which they may be located, and with passive motions of the skin. He thus was probably the first to publish the method of locating a foreign body by determining the point in the skin nearest to it, a method described again by Holzknecht in 1914, and by several others in 1915.

1900.—This year marked the publication of a very extensive work on the principles and applications of stereoscopic roentgenography by Lambertz, and the description of Barrell's metal cylinder method, very similar to that described by Caldwell in 1898 before the staff of the New York Polyclinic.

1901.—The ring localizer was again described, this time under the name "prevetograph" by Addyman in his book on "Practical *X*-Ray Work."

A caliper method was brought out this year by both Caldwell and Little. Caldwell's device was a special caliper, the ends

of the caliper arms being so shaped that when the shadows of the two were superimposed, they formed a cross. One arm of the caliper was flat so as to fit more closely against the screen. Little's caliper was fitted with a graduated direct-reading scale.

The malleable metal device susceptible of being moulded to the part under study was further developed by Fox who made a complicated metal frame arrangement to assist in locating a bullet in the head.

Caldwell this year described and produced stereofluoroscopy, the principles of the device being in the main similar to those of Mackenzie Davidson. Several new ideas were introduced, however, as follows: (1) The conception of the double-focus tube; (2) an electrically controlled shutter; (3) the shutter run by the same current which activated the tube, so that the shutter and tube action were synchronous.

Another entirely new localization principle was first published this year, that of inserting a needle into the tissues to the site of the foreign body, and leaving the needle *in situ* as a guide to the surgeon in removing the projectile. This method was published under the term "fremdkoerperpunktion" by Perthes.

1902.—Van der Goot described a method similar to that of Sechehaye (1899).

1903.—Bermbach published a highly complex calculation method, which he believed was new. Apparently no new principle was added to that formula first published by Buguet and Gascar in 1896. Little described a direct-reading scale for the application of the single tube shift and triangulation method, apparently not different from several scales already described. Grünfeld and Perthes both published further studies on the "harpooning" method of locating foreign bodies. Moritz, whose name has always been prominently associated with orthodiagraphy, described a method of using the orthodiagraph for determining the location of projectiles.

1904.—Contremoulins continued the discussion and improvement of his apparatus for localizing, which, as before mentioned, was probably the forerunner of the Hirtz compass, now so popular in the French military hospitals. Grünfeld and Holzknecht continued their consideration of the "harpooning" method of localization, and Holzknecht brought out a special operating table for the extraction of projectiles under fluoroscopic screen guidance at the moment of the operation.

1905.—Nothing of importance in relation to foreign body localization or extraction was published this year. Notes relating to the Russo-Japanese war do not give much detail with reference to the *x*-ray work of either side. A few of the field hospitals of the Japanese army were equipped with portable *x*-ray equipment, but of a rather unsatisfactory nature, some of it run by hand. Localization apparatus is mentioned occasionally, usually on account of its absence, but no details of procedures are given in any of the literature available to the writer. Some of the hospital ships were equipped with roentgen apparatus, but the reports of the official observers indicate that it was little used. Most of the base hospitals, however, were equipped with first-class *x*-ray equipment, and the rays were extensively used, at least in the study of fractures. Perhaps a more thoroughgoing investigation of the literature would uncover more information as to the localization methods employed; one British observer, however, states that the Japanese surgeons felt that they could get along just as well without the *x*-ray as with it.

1906.—Shenton published a description of his method of employing the parallax principle in localization. Kocher described a compass, which served especially as a guide to the operator during extractions. No new principles were exhibited in the device. Hall-Edwards gives a long but very interesting and helpful account of his experiences in the localization of foreign bodies in civil practice.

1907.—Bailey presented a description of his method of using malleable metal strips moulded to the part under investigation. Carothers described the ordinary stereo-

scopic roentgenographic method in common use among *x*-ray workers, and calls attention to the value of this method in estimating the situation of foreign bodies.

1908.—Daviot wrote at length advocating the control of extractions of foreign bodies by intermittent observation with the fluorescent screen during the progress of the operation. Ironside Bruce published a description of a rather elaborate but very accurate device for inserting needles into the tissues, thus indicating the site of the projectile, a sort of compass for indicating to the surgeon at the time of the operation the exact position of the foreign body. The instrument could be removed to the operating room, sterilized, and a needle prepared and adjusted in a little holder of its own, the length which it projected beyond its own holder being made equal to the depth of the foreign body from the surface of the plate. The instrument having been placed in position, the needle was inserted, released from its holder and left in position. The surgeon then dissected down to the point of the needle which was usually found in contact with the foreign body.

1909.—Fürstenau published his caliper method, the instrument being graduated in order to be direct-reading. This method enjoyed considerable popularity as a device for private practice, but in times of war it did not prove sufficiently rapid.

Bouchacourt advocated the stereoscopic method as giving the most accurate data upon which to base anatomical localizations. Gillet published a very extensive treatise on stereoscopic roentgenography.

The single shift triangulation method was further considered by Perdu, by Kreuzfuchs and by Müller.

1910.—In America, Coon described a practical device for localizing foreign bodies for use in civil practice, Manges brought out an elaborate and attractive method of estimating the measurements of the female pelvis by means of stereoscopic roentgenograms, and called attention to the value of this method in the localization of foreign bodies.

1911.—The publications of this year were almost entirely devoted to the value of fluoroscopic screen control during the extraction of foreign bodies, and dealt particularly with the technic of the combined radio-surgical procedure. Wullyamoz designed forceps of special form to facilitate extractions without endangering the fingers of the operator, the forceps having blades bent at right angles. Laval, and later Raoult-Deslongchamps, wrote further on the subject, the latter describing a special design of radio-surgical table permitting the operator to see the fluoroscopic image with one eye, while the other eye observed the operative field. This method was described by Grashey this same year. Laval's paper is a well-illustrated elaboration of the work of Wullyamoz (Lausanne).

1912.—In America, Blake published a triangulation method, not new, which required a complex mathematical calculation. The same method had been employed with direct-reading scales which were certainly more convenient. Coleschi, in Italy, seemed to take the lead in the subject of localizations; summarizing methods, but not presenting any new principles. The same may be said of the work of d'Halluin.

1913.—Sorge gave an excellent review of the subject, and offered what he thought to be a new method, though it differs from those previously reported only in some minor mathematical details. LeNestour revived the subject of extraction of projectiles under screen control at the time of operation, and suggested that the difficulties encountered by the anesthetist working in the darkness could be eliminated by constructing a sort of tent to contain him and the patient's head, so that he could have a light upon the patient's face at all times during the operation. Another compass for the guidance of the surgeon during the operation of extraction was proposed by Miramond de Laroquette. This was a simpler form of compass than that of Hirtz, but its usefulness is correspondingly limited.

1914.—The majority of the papers of this year were published before the begin-

ning of the Great War. Aubourg and Lebon in January published an extensive review of the subject of localization. Locke again called attention to the value of *x*-ray aid at the time of the extraction operation. Henrard in March summarized the various means of localizing, and spoke favorably of the supplementary aid afforded by the telephone probe of Hedley.

Hirtz this year first published a description of the compass which bears his name, although the writer understood, while in France, that the compass was really first used in 1907. It is an instrument formed of three horizontal branches turning about a common center, bearing on each branch a vertical rod, adjustable in length and in position on the branch, so that the ends of the vertical rods can be brought in contact with the skin, the horizontal branches remaining level. A fourth peripheral rod traverses a hole in the very axis of the compass, or it may be attached to a curved branch which also revolves about the common center, the curve being such as to form the arc of a circle with a given radius. Space will not be devoted here to the description of the instrument, the reader being referred to previous numbers of the JOURNAL. The instrument has been very widely used during the present war and is at present the standard method in most of the French hospitals. It is reserved for difficult cases, and especially for late removals, as contrasted with methods for localization of foreign bodies to be removed within a few hours of the injury when the surgeon must of necessity open up the original wound in the course of his necessary work. This method is not primarily a localization procedure so much as a means of providing the surgeon with a guide to be used once more during the course of his operation for extraction of the projectile. The most exact results are obtained when the method is used roentgenographically, but the instrument also serves very satisfactorily when used by means of the fluoroscope, with the added advantage of reducing the time of the localization to four or five minutes.

After the opening of hostilities, papers began to appear at an increasing rate until the curve of production of articles on the subject reached the highest point during 1915. The earliest papers on localization based on experiences in the present war were written by Wilson, who recommended the method of right-angled planes; Manuel and Nogueras described the single tube shift method, and produced a graduated direct-reading scale, the tube being shifted 20 cm.; Jaugeas recommended the single tube shift method, moving the focus 15 cm. between measurements; while Haret, employing the same method, shifted his tube 10 cm. Prof. Béclère also recommended and taught this method, all the men mentioned preferring to use it as a screen procedure. Haret also devised a wall scale which permitted direct reading of the depth of the projectile by using a thread to reconstruct the triangles formed during the procedure, thus reading the distance from screen to projectile. Hernaman-Johnson recommended the ring localizer, marking four points on the skin, and reconstructing the intersection of the two diameters passing through the projectile.

1915.—Space is too small for an adequate review of the work of this year. The work of Ombredanne and Ledoux-Lebard should be consulted for a complete exposition of the more useful roentgenologic methods of localization and extraction of projectiles which have grown out of the experiences of the present conflict.

Blake revived the cylinder method of Barrell.

Bramwell recalled attention to the triangulation method, using an arithmetical formula for calculating the depth of projectiles. The triangulation method, as practiced and automatically measured by the wall device of Haret, or by a direct-reading scale (*barême*), was further discussed by Charlier, Clark, Colardeau, Coleschi, Cotton, Davidson, Duncan, Hallam, Hampson, Jallot and Guerrée, Lagoutte, Mackenzie, Ménard, D. F. Shearer, Stenning, Viallet and Dauvillier, and by

Thurstan Holland who also devised a wall metric arrangement similar to Haret's for direct reading of the depth. Many of these writers doubtless believed their pet methods original with them at the time of their publication, though a perusal of the literature shows that the method is as old as roentgenology, having been first described by Buguet and Gascar in 1896.

The parallax method found preference in the writings of Jordan, LeFaguays, and Pirie.

Debierne and Vergely both described the multiple diameters method, and Vergely employed cardboard cut-outs conforming to the outline of the part studied, upon which he reconstructed the diameters and located the projectile.

Harris discussed the "nearest point" method, previously mentioned as first described by Wildt in 1899.

Hirtz and Gallot brought out their "pierced screen" method, which has found considerable favor among French *x*-ray workers.

Baese, in Italy, constructed a special device by which the tube and screen always moved together, the vertical rays from the tube being always perpendicular to the screen. This instrument is a very ingenious device by which the depth of a foreign body can be read off almost instantly in any diameter. It has not found favor in France, however, for some reason. It has the disadvantage of being of use only for the localization of foreign bodies, although it is as elaborate as most combination tables and tubestands.

Shaxby described his "ladder," a sort of grid device similar to the Dennis fluorometer used in 1898. The method recommended by Stenning involved the use of a special localizing mat, consisting of a number of pieces of straight lead wire embedded in a sheet of transparent material, parallel and equidistant. By means of a direct reading scale the depth is readily estimated.

H. Béclère and Mayet both spoke in commendation of the stereoroentgenographic method, calling special attention to the greater ease and accuracy of correct anatomical localization when the stereoplates were possible.

As an operating guide, the Hirtz compass continued to find enthusiastic support, and several other instruments serving a similar purpose were described: (1) The apparatus of Aubourg; (2) an elaborate instrument of Ironside Bruce, a further development of the instrument previously described by him seven years before; (3) a sort of Hirtz compass by Buffon and Ozil; (4) Lebon used the malleable band method, recommending the use of block tin; (5) a "radiologic sextant" by Loro; (6) an elaboration of the Mackenzie Davidson apparatus by Marion, the so-called Marion-Danion Compass, which not only permitted the visualization of the position of the foreign body in space, but furnished the surgeon with an operating guide, simpler than the Hirtz compass but also less generally applicable; (7) a special belt of wood and malleable metal which could be adjusted to the part, and in reference to which localizations could be made; (8) Menuet specially commended the Hirtz compass.

Screen aid in the surgical extraction of projections was discussed and recommended by J. R. Caldwell, Gosset, Réchou, and by Ledoux-Lebard and Dauvillier, the latter authors specially commending the "bonnet fluoroscope" which permits intermittent screen control of the surgical removal while the operation is being carried on in the usual bright light of the operating room. Lefort discussed the application of the electromagnet under the guidance of the screen observations.

1916.—The single tube shift triangulation method, used with a wall metric device, a direct reading scale or a chart, was further described by Desplats, Laroquette and Lemaire, Mahar, Oram, Gamlen, and Kirkwood. Gamlen employed small screens so that by pressure he could always assure definite contact with the skin, thus eliminating the factor of error due to the distance the screen may rest above the skin of the

part measured. Kirkwood preferred to mark the skin rather than the screen to make sure of correcting this source of error.

The "nearest point" method was recommended by Bocciardo.

The parallax principle formed the basis of the method of Grandgérard who also devised a rough compass to serve as an operating guide.

A method of two equal triangles, involving special apparatus by which the screen could be moved upward from the patient without disturbing any of the other relations, the height to which the screen is elevated being equal to the depth of the projectile, was described by Carver, by Guyenot, and by Shenton. Shenton's date of publication antedates both the other authors.

The trocar and cannula method was supported by Lyle who attributed the method to Sutton. Flint described the profondometer method which combined the malleable band idea, the trocar and cannula method, and the utilization of multiple diameters each passing through the projectile.

Barclay added a new idea in the bell-ringing forceps, as an aid to the surgical extraction of projectiles.

Belot and Fraudet and Nogier advocated and discussed the "*méthode de la pince*," a ring localizing method, for which special localizing forceps were devised, somewhat similar to the calipers described so many years before by E. W. Caldwell.

A very simple, rapid method, with double tube shift and double fixed wires, obviating the need of knowing the focus-screen distance or the distance of tube shift, was devised by Strohl. The article by de Moncetz is similar, though less exact.

A simple form of compass for operating guidance was devised by Maréchal, and simplifications of the Hirtz compass technic were suggested by Chaperon and Vanderhaegher, by Charlier, and by Morin and H. Béclère. The latter authors especially simplified the calculations necessary for the working out of the Hirtz compass method.

The stereoscopic method was again advocated by Beck, by Colombo, and by Ribaut and Brocq. Beck produced a two-volume atlas illustrating many types of foreign bodies, few of them, however, the result of firearms. Ribaut and Brocq especially dwelt on the necessity of using stereoscopy in order to secure accurate anatomical localization.

Extraction methods were discussed by Barclay, whose bell-ringing forceps is above alluded to; by Lamarche, who favored the telephone probe and the *électro-vibreur* at times as adjuncts to the screen control method; and by Monod who preferred extractions under the screen. Monod called attention to the fact that seventeen per cent of foreign bodies are not magnetizable, and hence cannot be vibrated with the *électro-vibreur*.

Sources of error in foreign body localization were discussed by Eager, Lehman, Ghilarducci and Maragliano. Metcalf and Keys-Wells published an elaborate and very valuable table of depths from various points on the skin to various internal organs and tissues. This table should be on the wall of every roentgen examining room for frequent reference.

1917.—Last year witnessed a considerable falling-off in the number of articles relating to the localization of projectiles. Shaxby continued the consideration of his "ladder" method. Tousey brought out again the "grid" method, now nearly twenty years old. Young, quite independent of previous workers, devised an apparatus almost a duplicate of that of Le Faguays for the utilization of the parallax method. Castelvecchio and Pittarelli both published complex mathematical methods which do not seem to present any practical advantage over the other methods already in common use. Aimé published a method of employing the Hirtz compass with the screen in place of the more tedious plate method. Deverre devised another chart for estimation of depth by the triangulation

method, single tube shift, using a direct-reading scale. Coppola discussed modifications of the ordinary *x*-ray operating table for the purpose of better suiting the needs of radio-surgical procedures.

Eastman and Bettman, in America, after spending some time in Austrian hospitals, described the localization methods in use in the Austrian armies; and Bettman describes his "bonnet fluoroscope" which is identical with the bonnet already described by several French authors, notably Dessane.

Cole of New York described a localizing device which, while very useful, does not embody any new principles. It is best adapted to a double tube shift, triangulation method. It has attachments giving it some of the characteristics of the profondometer method, and a guide for the surgeon during the operation of extraction.

A very good summary of the methods actually in use in the military hospitals was published by Wilkins, speaking from experience in the British army, and by Luisada.

In the foregoing pages, the writer has attempted to give a concise summary of the development of the elaborate list of localization methods in use to-day. In the following pages is given a list of the authors, titles and references, the arrangement being in alphabetical order. A great deal more might have been said, but on account of the limitations of time and space, it is thought best to leave the subject here, hoping that this presentation will be of great interest to many and of special service to those whose inventive minds may tempt them to spend valuable time in the development of what will very likely prove to be a rediscovery.

It is easily noted that German references are conspicuous by their absence, owing to the fact that since early in 1915 the delivery of German and Austrian medical periodicals has been suspended. Dutch, Scandinavian, and Russian references have also been omitted, in fact the writer was able to find but very few of them.

BIBLIOGRAPHY

ABADIE, J. "Sur les appareils de repérage radiographique de M. Masson (d'Oran)." *Bull. et mém. Soc. de Chir. de Par.*, 1915, n. s., xli, p. 2063.

ADDYMAN. "Practical *X*-Ray Work." 1901.

AIME, P. "Dispositif d'écran percé pour le repérage des corps étrangers à la radioscopie." *J. de radiol. et d'électrol.*, March-April, 1917, iii, p. 533.

ALBERS-SCHOENBERG. "Beitrag zur Projektildiagnose." *Deutsche med. Wchnschr.*, 1915, xli, p. 1477.

ANDRAULT, G. "Sur une méthode de zéro fournissant immédiatement en vraie grandeur la profondeur du projectile à localiser." *Progrès. méd.*, Apr. 5, 1916, p. 54.

ANGERER (Munich). "Die Lagebestimmung von Fremdkoerpern mittels Roentgendurchleuchtung." *Centralbl. f. Chir.*, May 7, 1898.

ARAUJO (Lima). "Novo processo para a determinacao exacta da posicao dos corpos extranhos no organismo." *Rev. da Soc. de med. e cirurg.*, March, 1898.

AUBOURG ET LEBON. "Procédés de localisation des projectiles et corps étrangers par les rayons X." *Répért. de méd. internat.*, Paris, 1914, Jan., iv, fasc. 37, p. 17.

BAESE, C. "Il Radiostereometro Baese." *Radiol. med.* Torino, 1915, p. 314.

BAILEY, C. FRED. "*X*-Ray Method for Immediate Localization of Foreign Bodies." *Brit. M. J.*, Nov. 2, 1907, p. 1207.

BARCLAY, A. E. "Preliminary Note on a New Method of Bullet Extraction." *Arch. Radiol. & Electroth.*, April, 1916, xx, p. 359.

BARRELL, F. R. "A New Method of Localization without Plumb-line of Threads." *Arch. Roentg. Ray*, iv, 1900, p. 98.

BECK, E. "Localization of Foreign Bodies with Stereoscopic Roentgenograms." 1916.

BÉCLÈRE, H. "Note sur la radiographie simple en deux positions et la radiographie stereoscopique au point de vue de la recherche des corps étrangers." *Paris chirurg.*, 1915, vii, p. 14.

BELOT AND FRAUDET. "Procédés de repérage des projectiles." *J. de radiol. et d'électrol.*, Paris, Feb., 1916, p. 18.

BERGONIE. "L'électrovibreur." *Arch. d'électric. méd.*, May-Sept., 1915.

BERMBACH, P. "Ein neurer Apparat zur Lokalisation von Fremdkoerpern." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, VII, no. 1, p. 33, 1903–4.

BLAKE, G. G. "An Improved Method of Localization of Foreign Bodies by Means of *X*-Rays." *Arch. Radiol. & Electroth.*, xx, p. 69, July, 1915.

BLAKE, G. G. "Further Notes on Localization." *J. Röntg. Soc.*, 1916, p. 22.

BLAKE, J. E. "*X*-Ray Localization of Foreign Bodies. A New Method Based upon Displacement of Shadows." *N. Y. State J. M.*, 1912, p. 11.

BOCCIARDO, D. "Un facile methodo de localizzazione dei proiettili." *Policlin.*, Roma, July 23, 1916, p. 921.

BOUCHACOURT, L. "Sur les avantages de la radiographie stéréoscopique dans la recherche des corps étrangers." *Bull. et mém. Soc. de radiol. méd. de Par.*, 1909, p. 74.

BRAMWELL, H. R. "An Arithmetical Help Towards *X*-Ray Localization." *Brit. M. J.*, 1915, i, p. 157.

BRUCE, W. IRONSIDE. *Brit. M. J.*, Sept. 12, 1908, p. 724.

BRUCE, W. IRONSIDE. "An *X*-Ray Director for the Removal of Foreign Bodies in the Tissues." *Arch. Roentg. Ray.*, London, Jan., 1915, p. 34.

BUFFON AND OZIL. "Procédé de localisation des projectiles par les rayons *X*; repéreur normal." *Arch. d'électric. méd.*, 1915, xxiii, p. 329.

BUGUET AND GASCAR. "Détermination a l'aide des rayons *X* de la profondeur ou la siège d'un corps étranger dans les tissus." *Compt. rend. Acad. d. Sc.*, Par., p. 457, March 30, 1896.

CALDWELL, E. W. "Clinic of the New York Polyclinic Hospital." 1898.

CALDWELL, E. W. "A Device for Stereofluoroscopy." *Electrical Review*, Dec., 1901.

CALDWELL, E. W. AND PUSEY, W. A. "Radiography and Roentgen Therapeutics." 1904.

CALDWELL, J. R. "Removal of Foreign Bodies on the *X*-Ray Table." *Lancet*, April 24, 1915, p. 854; May 15, 1915, p. 1018; June 2, 1915, p. 1342.

CARMAN, R. D. "*X*-Ray Localization of Foreign Bodies." *J. Missouri M. Ass.*, 1910–11, vii, p. 214.

CAROTHERS, R. "An Improved and Accurate Method of Locating Foreign Bodies with the Roentgen Rays." *J. Am. M. Ass.*, 1907, xlviii, p. 1599.

CARVER, A. E. "A New Method of Localizing Foreign Bodies by the Fluorescent Screen." *Arch. Radiol. & Electroth.*, May, 1916, xx, p. 423.

CASTELVECCHIO, C. B. DI. "In tema de localizzazioni geometriche." *Radiol. med.*, Torino, 1917, iv, p. 6.

CHAPERON AND VANDERHAEGHER. "Contrôleur pour le réglage du localisateur de Hirtz." *J. de radiol. et d'électrol.*, ii, p. 46, Jan.-Feb., 1916.

CHARLIER, A. "Nouveau procédé radiographique pour regler le compas de Hirtz." *J. de radiol. et d'électrol.*, 1916, ii, p. 43.

CHARLIER, A. "Nouveau procédé de repérage radioscopique des projectiles." *Bull. Acad. de méd.*, Par., 1915, s. 3., lxxiv, Dec. 28, 1915, p. 815.

CLARK, T. "Fluorescent Screen Localizer." *Arch. Radiol. & Electroth.*, July, 1915, xx, p. 73.

CLARK, T. "Apparatus for Localizing Bullets and Other Foreign Bodies." *J. Röntg. Soc.*, London, 1915, xi, p. 15.

CLEVELAND, A. J. "The Accurate Localization of Foreign Bodies in the Tissues by the *X*-Rays." *Arch. Roentg. Ray*, Lond., 1914–15, xix, p. 290.

COHN, M. "Ueber Fremdkoerperlokalisation." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, xv, No. 4.

COLARDEAU. "Notice sur la localisation des corps étrangers dans l'organisme par la radiographie." *Presse méd.*, 1915.

COLE, L. G. "Localization of Foreign Bodies." *Am. J. Roentgenol.*, Sept., 1917, n. s. iv, p. 455.

COLESCHI, L. "Metodo pratico per determinare la sede e la grandezza dei corpi estranei." *Policlin.*, Roma, 1912, xix, sez. prat., p. 517.

COLOMBO, A. "La radiologia stereoscopica quale metodo di localizzazione dei proiettili." *Pensiero med.*, 1916, vi, p. 349.

CONTREMOULINS, G. "La localisation radioscopique des corps étrangers dans l'organisme." *Rev. scient.*, Paris, 1904, 5. s., ii, p. 519.

COON, C. E. *Tr. Am. Roentg. Ray Soc.*, 1910.

COPPOLA, A. "Un nuovo letto per operazioni asettiche con controllo radioscopico." *Radiol. med.*, Milano, 1917, iv, p. 240.

COTTON, W. "An Apparatus for *X*-Ray Localization." *Brit. M. J.*, 1915, i, p. 464.

COTTON, W. "Some Principles of *X*-Ray Localization." *Practitioner*, Lond., 1915, xciv, p. 513.

DAVIDSON AND HEDLEY. "A Method of Precise Localization and Measurement by Means of Roentgen Rays." *Lancet*, Oct. 16, 1897.

DAVIDSON, JAMES MACKENZIE. "Roentgen Rays and Localisation." *Brit. M. J.*, Jan. 1, 1898.

DAVIDSON, J. M. "Remarks on the Value of Stereoscopic Photography and Skiagraphy." *Brit. M. J.*, Dec. 3, 1898.

DAVIDSON, J. M. "Localization of Foreign Bodies in the Eye and Orbit." *Brit. M. J.*, Feb. 5, 1898.

DAVIDSON, J. M. "The Principles and Practice of the Localization of Foreign Bodies by *X*-Rays." *Brit. M. J.*, 1915, i, p. 1.

DAVIOT, L. "Étude sur la recherche et l'ablation des corps étrangers, . . . sous le contrôle direct des rayons." *Octavo*, Paris, 1908, p. 397.

DEBIERNE. "Sur une méthode de localisation des corps étrangers par radioscopie." *Presse méd.*, Par., Mar. 4, 1915, xiii, p. 69.

DENNIS FLUOROMETER. Referred to in Walsh "The Roentgen Rays in Medical Practice." 1899.

DESPLATS, R. "Methode radioscopique de localisation des projectiles." *Paris méd.*, 1916, vi, p. 421, April 29, 1916.

DRÜNER. "Ueber die Lagebestimmung von Fremdkoerpern." *Verhandl. d. deutsch. Röntg.-Gesellsch.*, 1905.

DUNCAN, J. W. "Localization of Foreign Bodies by *X*-Rays." *Brit. M. J.*, 1915, ii, p. 75.

DUPRAZ. "Les chances d'erreur dans la recherche des corps étrangers par les rayons Roentgen." *Rev. méd. de la Suisse Rom.*, 1896, xvi.

EAGER, W. H. "Fallacies in the Localization of Foreign Bodies by the *X*-Rays." *Canad. M. Ass. J.*, 1917, vii, p. 51.

EASTMAN AND BETTMAN. "The *X*-Ray in War Surgery and Its Relations to the Removing of Foreign Bodies." *Ann. Surg.*, lxvi, No. 1, July, 1917.

EXNER, S. "Eine Vorrichtung zur Bestimmung von Lage und Grösse eines Fremdkörpers mittelst der Roentgenstrahlen." *Wien. klin. Wchnschr.*, Jan. 7, 1897.

FERRARI, G. "Metodo radioscopico semplice ed esatto per determinare la sede di taluni corpi estranei opachi." *Gazz. internaz. di med.*, 1911, xiv, p. 857.

FLINT, J. M. "Localization and Extraction of Projectiles." *Ann. Surg.*, August, 1916, p. 151.

FLINT, J. M. "A Combined Method for the Localization and Extraction of Projectiles." *Mil. Surgeon*, March, 1917, p. 259.

FOX, W. R. "The Localization of Foreign Bodies by the *X*-Rays." *Lancet*, Sept. 21, 1901, ii, p. 784.

FÜRSTENAU. "Ueber einen neuen Roentgentiefenmesser." *Zentralbl. f. Chir.*, 1909, No. 51.

GALEAZZI, R. "Ueber die Lagebestimmung von Fremdkoerpern vermittelst Roentgenstrahlen." *Zentralbl. f. Chir.*, 1899, No. 18, p. 529.

GAMLEN, H. E. "A Simple, Rapid and Accurate Method of Localization of Foreign Bodies." *Arch. Radiol. & Electroth.*, Nov., 1916, xxi, p. 175.

GERARD. (Method described by Vilain and Maffei.) "Procédé géometrique de determination des corps étrangers inclus dans les tissus." *Clinique*, Brux., May 13, 1897.

GHILARDUCCI, F. "Supra alcune modalita techniche per rendere piu agevole, rapida ed esatta la ricerca dei proiettili." *Policlin.*, Roma, 1916, p. 37.

GHILARDUCCI, F. "Sopra un metodo semplice ed esatto per la localizzione radiografica dei corpi estranei." *Policlin.*, Roma, 1916, xxiii, sez. prat., p. 325.

GHILARDUCCI, F. "Sopra di alcune cause di errore nella ricerca e nella localizzazione dei proiettili." *Radiol. med.*, Milano, 1917, iv, p. 1. Also loc. cit., p. 207.

GILLET (Berlin). "Eine Modifikation des stereoskopischen Verfahrens zur bestimmung der Lage von Fremdkoerpern." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, ix, 6; x, 2; xi, 3; xii, 6.

GILLET. "Neue Erfolge in der Bestimmung der Lage von Fremdkoerpern." *München. med. Wchnschr.*, 1910, No. 35.

GOSSET, A. "Corps étrangers extraits par la méthode de Wullyamoz." *Bull. et mém. Soc. de Chir. de Par.*, 1915, n. s. xli, p. 772.

GRANDGERARD, R. "Méthode radioscopique de localisation des projectiles par lecture directe et appareil de recherche chirurgicale." *Paris méd.*, 1916, p. 165.
GRANGER, AMEDEE. "Device for the Localization of Foreign Bodies by Means of the *X*-Rays." *N. Orl. M. & S. J.*, lxx, No. 7, Jan., 1918, p. 585.
GRASHEY. "Roentgenoskopische Operationen im taghellen Raum." *Beitrag. z. klin. Chir.*, Tübing., Bd. lxx.
GRÜNFELD. "Vorläufige Mitteilung in der Sitzung der k. k. Gesell. f. Aerzte in Wien." *Wien. klin. Wchnschr.*, 1903, No. 12.
GRÜNFELD AND HOLZKNECHT. "Die Fremdkoerperharpunierung." *Zentralbl. f. d. ges. Therap.*, 1904, xxii, p. 57.
GUILLEMINOT. "Radioscopie et Radiographie." Paris.
GUILLOZ. "Procédé pour la determination de la position des corps étrangers dans l'organisme par la radiographie et la fluoroscopie." *Arch. d'électric. méd.*, 1900, p. 338.
GUYENOT, P. L. "Un nouveau procédé de localisation radioscopique des projectiles en chirurgie de guerre." *Arch. d'électric. méd.*, June, 1916, p. 172.
HALLAM, R. "New Apparatus for the Localization of Foreign Bodies." *Arch. Radiol. & Electroth.*, Dec., 1915, xx, p. 235.
HALL-EDWARDS. (Referred to in Walsh: "The Roentgen Rays in Medical Practice." 1899.)
HALL-EDWARDS. "Ten Years' Experience in the Localization of Foreign Bodies by Means of the *X*-Rays." *Med. Electrol. & Radiol.*, Lond., 1906, vii, p. 44.
D'HALLUIN, M. "Localisation des corps étrangers; introduction d'un repére interne, et radiographie stéréoscopique." *Bull. et mém. Soc. de radiol. méd. de Par.*, 1913, v, p. 335.
HAMPSON, W. "Localizing Simply and Immediately." *Arch. Roentg. Ray*, 1914–15, xix, p. 203.
HAMPSON, W. "A Localizing Device." *J. Röntg. Soc.*, London, Jan., 1915.
HARET AND SCHLESINGER. "Un dispositif très simple pour la localisation des projectiles par la radioscopie." *Bull. Acad. de méd.*, Paris, 3 s., Dec. 29, 1914, p. 446.
HARRIS, H. "A Method for *X*-Ray Localization." *Brit. M. J.*, 1915, i, p. 113.
HARRISON. "Roentgen Rays and Localisation." *Brit. M. J.*, Feb. 12, 1898.
HEDLEY. "A Case of Localization." *Arch. Röntg. Ray*, Feb., 1898.
HENRARD, E. "L'état actuel du radiodiagnostic des corps étrangers." *Bull. et mém. Soc. de radiol. méd. de Par.*, March, 1914, vi, p. 83.
HIRTZ, E. J. "Méthode radiographique et appareil simple pour la localisation précise et la recherche des corps étrangers." *Bull. et mém. Soc. de chir. de Par.*, March 25, 1914, n. s. xl, p. 373.
HIRTZ, E. J., AND GALLOT. "Nouveau procédé radioscopique de determination de la profondeur d'un corps étranger dans l'organisme." *Compt. rend. Acad. d. sc.*, Paris, 1915, clx, p. 489.
HOLZKNECHT, G. "Ein radioskopisches Operationstischen zum Anaschulso." *Fort. a. d. Geb. d. Röntgenstrahlen*, 1904–5, viii, p. 344.
IMBERT AND BERTIN. "Radiographie stéréoscopique." *Compt. rend. Acad. d. sc.*, Paris, March 30, 1896.
JALLOT AND GUERRBE, A. L. "Moyen pratique pour trouver par la radioscopie directement et sans calcul la profondeur en centimétres d'un projectile sous la peau." *Arch. méd. d'Angers*, 1915, xix, p. 181.
JAUGEAS. "Localisation précise des projectiles par la radioscopie." *Bull. Acad. de méd.*, Par., 1914, 3 s., Dec. 29, p. 455.
JOHNSON, F. HERNAMAN. "A Simple and Rapid Method of Localizing Bullets." *Arch. Röntg. Ray*, Dec., 1914, xix, p. 247.
JORDAN, A. C. "Fluorescent Screen Localization by the Parallax Method." *Arch. Radiol. & Electroth.*, Nov., 1915, p. 188.
KIRKWOOD, W. L. "Notes on the Localization of Foreign Bodies by *X*-Rays." *Med. J. Australia*, March 18, 1916, i, p. 239.
KNOX, R. "Radiography." London.
KOCHER. "Appareils très simples pour localiser les corps étrangers par la radioscopie." *Rev. méd.*, Paris, Aug., 1906, xv, p. 495.
KREUZFUCHS, S. "Eine einfache Lokalisationsmethode." *Fort. a. d. Geb. d. Röntgenstrahlen*, 1908–9, p. 243.
LAGOUTTE. "Un procédé de localisation des corps étrangers par la radiographie." *Lyon méd.*, 1915, cxxiv, p. 73.
LAMARCHE, E. "Etude critique des méthodes de localisation des projectiles par la radiographie." *Montpel. méd.*, July 15, 1916, p. 108.
LAMBERTZ. "Die Perspektive in dem Roentgenbildern und die Technik der Stereoskopie." *Fort. a. d. Geb. d. Röntgenstrahlen*, iv, No. 1, 1900.
DE LAROQUETTE AND LEMAIRE. "Table des coefficients d'aggrandissement des images radiographiques utilisable pour la localisation des projectiles dans les tissus." *Paris méd.*, 1916, Feb. 5, p. 168.
LAVAL, E. "Extraction des corps étrangers au moyen de la pince à angle droit par la méthode du Dr. Wullyamoz." *Caducée*, Par., 1911, xi, p. 203.
LAVIALLE, A. "Description technique de l'indicateur operatoire Aubourg pour faciliter l'extraction des corps étrangers." *J. de radiol. et d'électrol.*, Paris, 1916, ii, p. 40.
LEBON, H. "Localisation exacte des corps étrangers metalliques dans les tissus au moyen des rayons *X*." *Progrès méd.*, Paris, 1914–15, 3 s., p. 405.
LEDOUX-LEBARD AND DAUVILLIER. "Nouvelle méthode radioscopique de recherche sure des corps étrangers pendant les interventions chirurgicales." *Compt. rend. Acad. de sc.*, Paris, 1915, clxi, p. 575.
LE FAGUAYS. "Note sur un appareil de localisation de projectiles." *J. de radiol. et d'électrol.*, 1915, p. 711.
LEFORT, R. "Note sur une méthode pratique d'extraction des corps étrangers magnetiques par l'électro-aimant sous radioscopie." *Bull. et mém. Soc. de chir. de Par.*, 1915, n. s., xli, p. 1480.
LEHMAN, P. "La recherche radiologique des projectiles." *Paris méd.*, Feb. 5, 1916, p. 171.
LEVY-DORN, M. "Die Lagebestimmung von Fremdkoerpern mittels Roentgendurchleuchtung." *Centralbl. f. Chir.*, Leipz., 1898, p. 617.
LITTLE'S CALIPERS. Referred to by Harrison Orton. *Tr. M. Soc. Lond.*, 1915, p. 107. Made by Little in 1901.
LITTLE, J. W. "A Rapid and Simple Method of Localizing Foreign Bodies by the *X*-Rays." *Lancet*, June 21, 1902, i, p. 1765.
LOCKE, W. L. "The Removal of Foreign Bodies from the Tissues with the Aid of the *X*-Ray." *Proc. Roy. Soc. Med.*, Lond., 1914–5, viii, Electrotherapeutic Section, p. 56.
LORO. "Sextant radiologique." *Arch. d'électric. méd.*, xxiii, 1915, p. 337.
LUISADA, E. "Profondimetro Luisada-Toccafondi." *Policlin.*, Roma, 1917, xxiv, sez. prat., p. 588.
LYLE, H. H. M. "Discussion before the New York Surgical Society on Wounds Complicated by Foreign Bodies." *Ann. Surg.*, Jan., 1916, p. 114.
MARECHAL ET MORIN. "Appareil repéreur nouveau pour la localisation radiologique des projectiles chez les blessés." *Compt. rend. Acad. d. sc.*, Paris, 1916, clxii, p. 232.
MACKENZIE, K. W. "A Rapid Method of Localization by *X*-Rays." *Brit. M. J.*, Jan. 2, 1915, p. 6.

MAHAR, V. "Dispositif permettant la mesure rapide et par simple lecture de la profondeur des projectiles dans les tissus par la radioscopie." *Bull. Acad. de méd.*, Paris, 1916, 3 s., lxxv, p. 259.

MANGES, W. F. "Measurement of Pelvic Diameters by *X*-Ray." *Tr. Am. Roentg. Ray Soc.*, 1910.

MANUEL Y NOGUERAS, V. "Nueva procedimiento radiografico para la localizacion de cuerpos extranos." *Rev. de med. y cirug.*, Barcelona, 1914, p. 129.

MARAGLIANO, V. "I raggi Roentgen nella traumatologia di guerra." *Cron. d. clin. med. di Genova*, Oct. 31, 1916, p. 109.

MARIE AND RIBAUT. "Stéréoscopie de précision appliquée à la radiographie." *Arch. de physiol. norm. et path.*, July, 1897.

MARION. "La localisation des corps étrangers avec le repéreur Marion-Danion." Paris. Imprimerie de la Cour d'Appel, 1915.

MAYET, H. "La radiographie stéréoscopique dans la recherche des corps étrangers," *Paris chirurg.*, 1915, vii, p. 18.

MAUCLAIRE, P. "Ablation des corps étrangers sous l'écran avec des gants de caoutchouc recouverts a leur interieur de solution caoutchoutée plombée." *Bull. et mém. Soc. de chir. de Par.*, 1915, n. s., xli, p. 1957.

MENARD, M. "Localisation radioscopique des corps étrangers par la méthode de Hirtz." *Compt. rend. Acad. d. sc.*, Paris, 1915, clx, p. 612.

MENUET, F. "Localisation des projectiles au moyen d'un repéreur special—méthode des contours." *Arch. d'électric. méd.*, xxiii, Mar., 1915, p. 57.

MERGIER. "Appareil pour determiner la position des corps étrangers dans les organs." *Bull. Acad. de méd.*, Paris, March 1, 1898.

METCALF, J., AND KEYS-WELLS, E. N. "The Anatomical Position of Localized Foreign Bodies." *Lancet*, May 27, 1916, p. 1078.

MILANI, E. "I metodi per la ricerca e localizzazione dei proiettili mediante i raggi Roentgen." *Riv. osp.*, Roma, 1916, vi, p. 242.

MIRAMOND DE LAROQUETTE. "Nouveau procédé radiographique de découverte des corps étrangers." *Paris méd.*, 1913–14, xiii, p. 411.

MITCHELL, WM. "An Aseptic Cryptofluoroscope for Use in the Operating Theatre." *Arch. Radiol. & Electroth.*, Oct., 1915, xx, p. 170.

MONCETZ, G. DE. "Localisation précise et rapide des projectiles par voie radioscopique." *Arch. d'électric. méd.*, 1916, xxiv; Sept. 25, p. 333.

MONOD, E. "De l'extraction des projectiles en lumière rouge sous le contrôle intermittent de la radioscopie." *Arch d'électric. méd.*, 1916, p. 82.

MORIN AND H. BÉCLÈRE. "Simplification de la construction graphique dans la localisation des projectiles par la méthode du compas de Hirtz." *J. de radiol. et d'électrol.*, Paris, Feb., 1916, ii, p. 31.

MORITZ, F. "Ueber Tiefenbestimmungen mittels des Orthodiagraphen und deren Verwendung um etwaige Verkurzungen bei der Orthodiagraphie des Herzens zu ermitteln." *Fort. a. d. Geb. d. Röntgenstrahlen*, 1903–4, vii, p. 169.

MORIZE. "Sur un nouveau procédé de determination de la position de corps étrangers par la radiographie." *Presse méd.*, Feb. 12, 1898.

MOWAT, H. "The Localization of Foreign Bodies by Means of the *X*-Rays." *Brit. M. J.*, London, 1915, i, 112.

MUELLER, CHR. "Einfache Methode zur Bestimmung des Tiefensitzes von Fremdkoerpern mittels Roentgenstrahlen." *München. med. Wchnschr.*, No. 32, p. 1645, Aug. 10, 1909.

NESTOUR, H. M. LE. "Extraction des corps étrangers sous le contrôle de la radioscopie." *Thèse de Bordeaux*, No. 61, 1912–13, Feb. 7, 1918.]

NOGIER, I. "Pince localisatrice pour le repérage rapide des corps étrangers par la radioscopie." *J. de radiol. et d'électrol.*, 1916, ii, p. 416.

OMBREDANNE AND LEDOUX-LEBARD. "Localisation et Extraction des Projectiles." Paris, 1917.

ORAM, W. "Some Aids to Accuracy and Rapidity in *X*-Ray Localization." *Arch. Radiol. & Electroth.*, London, 1916–17, p. 277.

PAYNE, E. "Localization and Measurement of Hidden Bodies by Aid of Roentgen Rays." *Arch. Roentg. Ray.*, Nov., 1897, p. 31.

PERDU. "Localisation par la radiographie des corps étrangers du cou ou des mêmbres." *Clinique*, Paris, 1909, iv, p. 489.

PERTHES, G. "Ueber Fremdkoerperpunktion." *Centralbl. f. Chir.*, No. 29, 1902.

PERTHES, G. "Radiographischer Nachweis und operative Entfernung einer Messerklinge nach siebenundzwanzigjährigem Verweilen im Wirbelkanal." *Fort. a. d. Geb. d. Röntgenstrahlen*, 1903–4, vii, p. 177.

PITTARELLI, E. "Sulla localizzazione radiologica dei corpi estranei." *Gazz. d. osp.*, Milano, 1917, xxxviii, p. 994.

RAOULT-DESLONGCHAMPS. "Nouvelle appareil permettant l'extraction des corps étrangers sous le contrôle simultané des rayons *X*. et de la vision directe." *J. de méd. de Par.*, 1911, 2 s., xxiii, p. 911.

RECHOU, G. "Extraction chirurgicale des corps étrangers sous écran." *Arch. d'électric méd.*, 1915, xxv, p. 237.

REMY AND CONTREMOULINS. "Nouveau perfectionnement des applications chirurgicales des rayons *X*." *Bull. Acad. de méd.*, Paris, March 30, 1897.

RIBAUT, H., AND BROCQ, P. "La localisation anatomique des projectiles par la radiographie stéréoscopique." *J. de radiol. et d'électrol.*, Paris, 1916, ii, p. 29.

SCHJERNING AND KRANZFELDER. "Zum jetzigen Stand der Frage nach Verwerthbarkheit der Roentgenstrahlen fur medicinische Zwecke." *Deutsche med. Wchnschr.*, No. 34, August, 1896.

SHAXBY, J. H. "A Screen Method of Localization." *Brit. M. J.*, 1917, ii, p. 389.

SHAXBY, J. H. "Localization of Foreign Bodies by Means of *X*-Rays." *Brit. M. J.*, 1915, ii, p. 11.

SECHEHAYE. "Etude sur la localisation des corps étrangers au moyen des rayons Roentgen." Bâle et Genève. Georg. et Compagnie, 1899.

SEHRWALD. "Die Lagebestimmung von Fremdkoerpern in der Tiefe bei der Durchleuchtung mit Roentgenstrahlen." *Deutsche med. Wchnschr.*, No. 19, May, 1898.

SHEARER, D. F. "Geometric Aids to *X*-Ray Localization." *Brit. M. J.*, 1915, i, p. 248.

SHENTON, E. W. H. "Localization of Foreign Bodies by Means of the *X*-Rays." *Practitioner*, 1906, Extra No. on *X*-Rays, p. 87.

SHENTON, E. W. H. "A New Method of Rapid *X*-Ray Localization." *Guy's Hosp. Gaz.*, London, March 25, 1916, xxx, p. 98.

SORGE, K. "Fremdkoerperlokalisation vermittels Roentgenstrahlen." Freiburg i. Br., Hamburg, 1913.

STECHOW. *Cong. internat. d. sc. méd. a Moscou*, Aug. 19–26, 1897.

STENNING, H. J. "A Simple Screening Method of Localization with the *X*-Rays." *Arch. Radiol. & Electroth.*, Nov., 1915, p. 205.

STROHL, A. "Procédé simple pour localiser rapidement les projectiles par la radioscopie." *J. de Radiol. et d'électrol.*, ii, No. 3, May–June, 1916, p. 173.

SUTTON METHOD (Described by E. H. Skinner, *Am. J. Roentgenol.*, July, 1917, n. s., iv, p. 350).

THOMPSON, ELIHU. *Electrical Review*, May, 1896.

TOUSEY, S. "A Method of Locating Bullets and Other

Foreign Bodies by the *X*-Rays." *United States Nav. M. Bull.*, Oct., 1917, xi, p. 544.
THURSTAN-HOLLAND, C. "*X*-Ray Work at the First Western Base Hospital." *Arch. Roentg. Ray*, xix, Feb., 1915, p. 307.
TURNER, D. "Localization of Foreign Bodies by Means of the Roentgen Rays." *Edinb. M. J.*, March, 1898.
VAN DER GOOT. *Geneesk. Courant*, Amst., 1902, xvi, No. 44.
VAN DER GOOT. "De methode Sechehaye voor het localiseeren van een vreemd lichaam door middle van Roentgenstralen." *Med. Rev.*, Haarlem, 1902, ii, p. 560.
VERGELY, A. "Méthode pour localiser exactement les projectiles après la radioscopie." *Presse méd.*, Feb. 18, 1915, p. 51.
VIALLET AND DAUVILLIER. "De la localisation des projectiles de guerre par la méthode radioscopique de la double image, perfectionnée par l'emploi de la reglette de Mazerès." *Arch. d'électric méd.*, 1915.
WAGG, H. "A Method of Radiography and Localization." *Arch. Roentg. Ray*, May, 1898.
WALSH. "Skin Pictures by *X*-Rays." *Brit. M. J.*, March 27, 1897.
WARLUZEL AND JOLLANT. "Recherche des corps étrangers et des points visibles interéssants dans l'interieur des corps permeables aux rayons *x*. *Association française pour l'avancement des sciences*, Boulogne-sur-Mer, 1899, p. 454.
WENTZLIK. "Localization of a Bullet in the Hip." *Fort a. d. Geb. d. Röntgenstrahlen*, Sept., 1897.
WESKI, O. "Die roentgenologische Lagebestimmung von Fremdkoerpern." Stuttgart, 1915.
WHITE, GOODSPEED AND LEONARD. "Surgical Applications of the Roentgen Ray." *Am. J. M. Sc.*, Aug., 1896.
WILDT, AUG. "Methode zur Tiefebestimmung von Fremdkoerpern." *Deutsche med. Wchnschr.*, 1899, No. 20.
WILKINS, W. A. "The Localization of Foreign Bodies." *Am. J. Roentgenol.*, July, 1917, n. s., iv, p. 343.
WILSON, W. R. "Localization by *X*-Rays." *Brit. M. J.*, 1915, i, p. 249.
WULLYAMOZ, F. "Extraction des corps étrangers sous le contrôle radioscopique au moyen de la pince à angle droit." Lausanne, 1911.
YOUNG, J. S. "A Simple Method of Localization of Foreign Bodies." *Arch. Radiol. & Electroth.*, London, July, 1917, xxii, p. 40.

THE INVERTED COMMA SIGN IN PULMONARY ROENTGENOLOGY*

BY A. W. CRANE, M.D.

KALAMAZOO, MICH.

THE inverted comma is a sign found in roentgenograms of the chest. It is located along the right margin of the main bronchus with the head at about the level of the bronchial bifurcation and the tail tapering upward along the bronchial border. The average size of the head is that of a pea. The length of the tail is three or four times the diameter of the head but is indeterminate because its extremity fades into the shadow of the margin of the bronchial tube.

It is a definite body distinct from the hilus glands and other structures. A study of stereoscopic plates shows that it is not an appearance due to the juxtaposition of other shadows. It does not consist of normal structures, viewed edgewise or otherwise, because it is found in a certain per cent of cases only. It cannot be made to appear and disappear by placing the patient in certain positions. It is often sufficiently dense to be seen with any position of the patient and in the more pronounced cases it can be followed by the eye as the patient is turned behind the fluorescent screen.

The comma is not, however, a proper subject for detection by the screen. It is a sign for plate study. It is best observed in stereoroentgenograms but is readily recognized on single anteroposterior plates. Prints and illustrations in books and periodicals rarely show the comma, although one set of the plates in the Dunham's "Pulmonary Stereoroentgenography" shows it with unquestionable distinctness. No special technic is required but it is an advantage to place the patient prone upon the plate with the face turned to the right so that the right side of the bronchus will be thrown beyond the shadow of the spine. Sufficient penetration to reveal the vertebral detail is desirable because the comma is frequently overlapped by other structures.

I first drew attention to the comma sign Oct. 14, 1914, before the Chicago

*Read before the American Roentgen Ray Society at the Eighteenth Annual Meeting, New York City, September, 1917.

FIG. 1. SHOWING SMALL DENSE INVERTED COMMA.

Apparently a normal chest. Calcification of hilus clusters absent.

Medical Society and exhibited a number of lantern slides illustrating it. At the mid-winter session of the western section of the American Roentgen Ray Society in Cincinnati, 1916, I again called attention to it and showed slides. I intended to make an exhaustive study of the comma at my leisure, but never finding leisure I have responded to an invitation of our president by bringing before you at this time a presentation of the inverted comma sign, which is still woefully incomplete in respect to pathologic and postmortem studies.

I have run through three hundred recent consecutive cases of which we had on record the case histories, the physical examinations, the laboratory findings and the *x*-ray studies. These cases were gastro-intestinal, renal, cardiac, psychopathic, etc., as well as pulmonary. Chest plates had been made in all the cases regardless of the fact that pulmonary symptoms were or were not present. Where the sign was doubtful the plate was counted as negative; in some cases I believe that better plates would have shown an unquestionable comma, so that I consider twenty per cent a conservative estimate.

We have made a thorough analysis of sixty positive cases. Of those under observation 24 were women and 29 men. Sex is not a factor. Seven were under 22 years of age, 27 were between 21 and 46, 18 were over 45 years, so that most of the cases were found in middle life. It has not been found by me in childhood. I can see no reason for this and believe that a sufficient series of cases would yield a positive percentage. Nineteen out of 52 were without pulmonary signs or symptoms excepting calcified glands; 64 per cent had pulmonary signs or symptoms; 48 per cent had an expectoration; 46 per cent had a cough; 15 per cent had tubercle bacilli in the sputum; 12 per cent had active tuberculosis. It is not, therefore, a sign of active tuber-

FIG. 2. SHOWING INVERTED COMMA.

Asymmetry of chest; calcification of hilus clusters; remains of left pleural effusion.

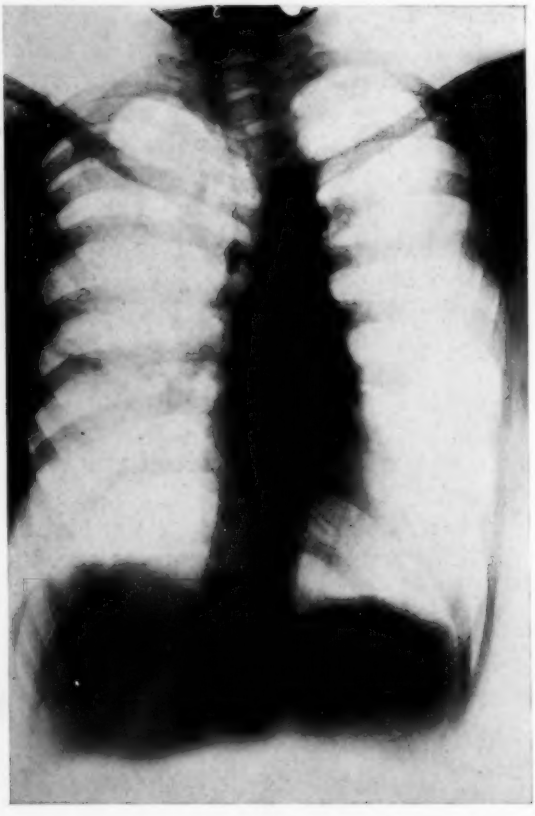

FIG. 3. SHOWING INVERTED COMMA.

Upper dorsal scoliosis to left leaving calcified comma in bold relief. No other pulmonary focus of calcification.

culosis. Known syphilis was present in but 2 out of 52 cases and a negative Wassermann was present in 8. It is obviously not a sign of pulmonary lues. Previous pneumonia was present in 19 per cent. Pulmonary infection other than tuberculosis was present in 19 per cent. Fever was present in 28 per cent; a leucocytosis in 38 per cent; marked oral sepsis in 35 per cent; pain in the chest in 17 per cent. Eighty-eight per cent had roentgen signs of pulmonary tuberculosis of some grade.

The size, shape and density of the comma vary in these cases to an extent which may be of clinical value. While the average measurement of the head on the plate is 0.7 cm for the short diameter and 1.2 cm for the long diameter, these dimensions are halved in some cases and trebled in others. It may be spherical or the usual oval may be greatly exaggerated. Instead of rounded ends, these may be pointed. The central portion of the head may show marked rarefaction, a finding which has been observed only in the larger bulbous types. Varying degrees of calcification may be found, which here as elsewhere in pulmonary structures may be taken as an index of chronicity. Variations in the tail are less marked but difference in thickness and density are observable.

From this analysis we would conclude that the inverted comma is a sign of tuberculosis; that it is a sign of a chronic, rarely an acute process; and that it signifies a past rather than a present infection. In the 23 per cent which were found in active cases of tuberculosis, the comma is possibly evidence of a previous infection.

Much remains to be answered. Is the comma evidence of a lymphogenous, an hemic, or an inspiratory origin of tuberculosis? If the latter, then is it evidence of a bronchial tuberculosis? Is it the result

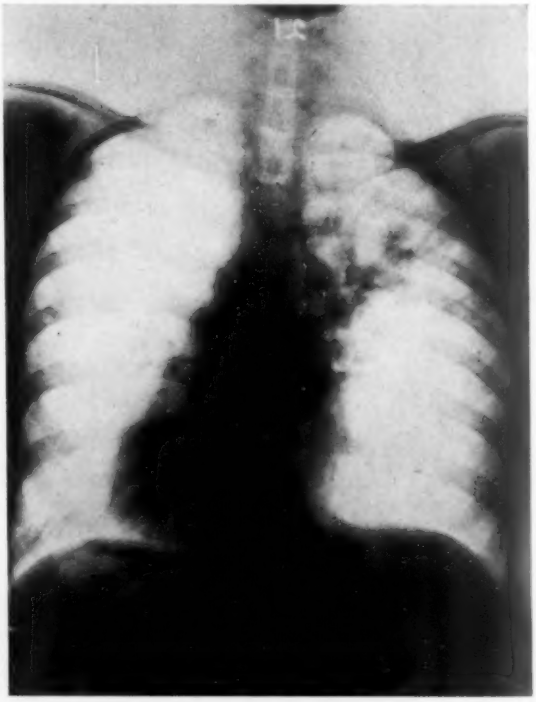

FIG. 4. SHOWING INVERTED COMMA.

Consolidation in left upper third showing cavity

of infection by the tubercle bacillus only or may it result from other types of infection? May it result from inorganic deposits as in pneumoconiosis? Why is it with rare exceptions found only on the right side? Is the comma when once present permanent, or may it be absorbed if not calcified? Why is it not present in all cases of pulmonary tuberculosis? Is this sign capable of practical application in *x*-ray diagnostics?

What is the comma, is a question to be decided by postmortem and pathological study. While at the Cincinnati meeting of the western section, following my communication on the comma, Dr. Kennon Dunham took several of the members to the City Tuberculosis Hospital where he had many lungs, preserved entire in large jars. He had stereoroentgenograms of them made after their removal postmortem. He selected one showing the comma sign and then dissected the lung to find the comma. It was readily found and was the size of a hazel nut. It appeared to be a calcified lymph gland. The tail could not be definitely separated but macroscopically was lymphoid tissue along the outer margin of the bronchus. Since then in an adult negro, dying of pneumonia, I found in the exact locality of the comma a swollen glandular structure shaped like a lima bean. It was not calcified. In two other cases, one without pulmonary lesions and one with secondary sarcoma, I could find nothing. But neither the negro nor the two other cases were *x*-rayed. From such scanty premises no conclusions can be drawn and on its pathological side the subject is practically untouched. But the likelihood remains that it is one of the bronchial glands which drains an area of special susceptibilities. It seems to be a single gland and not a conglomeration of several glands. No other bronchial gland and no bronchial adenopathy ever give a similar roentgenological appearance.

In his discussion of my paper at Cincinnati, Dr. Henry Hulst suggested that the comma was a lymphatic node in the

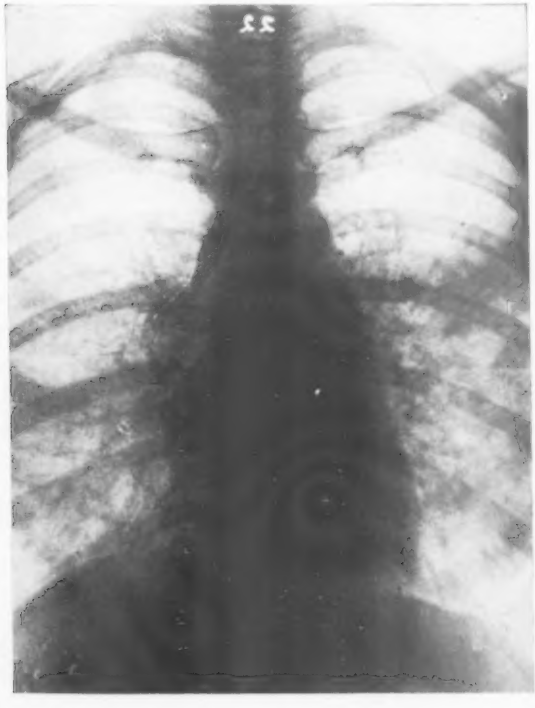

FIG. 5. SHOWING LONG, THICK INVERTED COMMA.

Parenchymatous involvement of lower two-thirds of both sides. Apices unaffected.

FIG. 6. SHOWING INVERTED COMMA.

Left hilus consolidation; remains of left pleural effusion; parenchymatous involvement of right upper third.

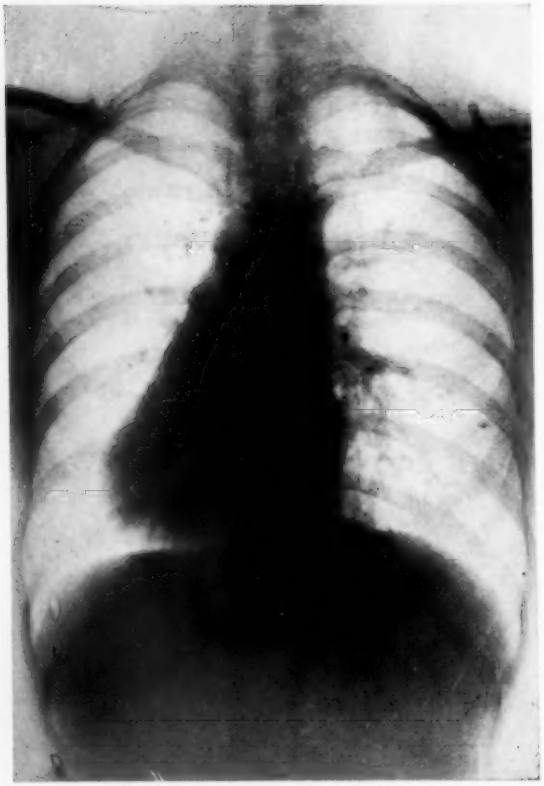

FIG. 7. SHOWING INVERTED COMMA ALONG BOTH RIGHT AND LEFT BORDER OF BRONCHUS.

Case of long-standing healed tuberculosis.

region of Tendeloo. This region extends from the 5th rib upward in the lung along the vertebral border as viewed on antero-posterior roentgenograms. This paravertebral area, Tendeloo describes as a region of biochemic susceptibility. The lymph flow is here relatively slower and tuberculosis of the lymphogenous type is likely to originate in this region. According to Tendeloo, human tuberculosis, in the overwhelming majority of cases is lymphogenous, and it is here that we should look for the first signs of incipient disease.

It is interesting to observe in this connection that in a certain proportion of early cases of tuberculosis the pulmonary lesion surrounds the comma so as to suggest it as the focus of extension. It may be possible that the presence of an enlarged gland at this particular point in the angle formed by the branching of the bronchus may exert sufficient pressure to impede the lymph-flow still farther and thus accentuate the natural susceptibilities of the paravertebral region.

At my request Dr. Hulst supplied me with Tendeloo's article in the *Transactions of the Sixth International Congress of Tuberculosis*, 1908. There is not the slightest hint in this of any structure resembling the comma.

The prominence and frequency of this sign lead me to wonder if it has not already been noted and described under other names. I know that many rediscoveries have been made in roentgenology due to the extent and difficulties of foreign scientific literature. For this reason I do not claim priority.

After twenty years of pulmonary roentgenology we are still beset with difficulties in recognizing specific signs of tuberculosis. The roentgenographic distinctions between an active and a quiescent lesion in the lung are most often doubtful in those cases where we most need to speak with decision, because of the uncertainty of the physical signs. For these reasons the inverted comma should be fully investigated and its diagnostic possibilities developed and applied.

A ROENTGENOLOGIC STUDY OF THE EFFECTS OF DUST INHALATION UPON THE LUNGS *

BY HENRY K. PANCOAST, M.D.
Professor of Roentgenology
and
T. GRIER MILLER, M.D.
Chief of Occupational Clinic
and
HENRY R. M. LANDIS, M.D.
Assistant Professor of Medicine, University of Pennsylvania
PHILADELPHIA, PA.

THE possible pathologic features and the various causes of increased thickness of the prominent linear shadows, especially those extending from the hilus to the base of so many individuals examined for tuberculosis and other conditions, have been questions about which more or less doubt has existed. Furthermore, it is frequently difficult to assign to their exact diagnostic value, in the detection of early pulmonary tuberculosis, the more isolated thickened trunk shadows often found in the apical regions. In attempting to derive a better understanding of the causes of these changes from normal appearances it was decided to approach the subject by a study of the chests of a large number of individuals engaged in various dusty occupations. This work was instituted about a year ago on a small scale, but it soon proved to be of so much clinical and roentgenologic interest that it has been continued throughout the past year as time could be spared.

As a rule, we have found firms and corporations quite willing to have the investigations carried out upon their employees, and it has frequently been to their advantage so to do, either by being assured that the dust inhaled by their men was not so harmful as was claimed, or by having ways and means suggested whereby the dangers from dust inhalations could be lessened. The Trenton Potteries Company and the Whitehall Cement Works have been most generous in supplying material and otherwise aiding us. A number of carpet, plush and silk workers were furnished through the kindness of Dr. J. W. Schereschewsky, Surgeon U. S. Public Health Service, and the remainder has been supplied through the Occupational Clinic of the University Hospital. Up to the present time one hundred and thirty seven individuals have been examined, distributed through the following occupations:

Organic dust	
Carpet and plush workers	18
Tobacco workers	13
Silk workers	1
Inorganic dust	
Potters	39
Metal grinders	20
Cement workers	20
Asbestos workers	15
Coal miners and marine firemen	10
Not classified	1
Total	137

Each case has had a thorough clinical examination, followed by a roentgenoscopic study and a roentgenographic examination by stereoscopic plates. The clinical and roentgenologic studies have

* Read at the Eighteenth Annual Meeting of the American Roentgen Ray Society, New York City, September, 1917.

been made independently, and as this is in the nature of a preliminary report during the progress of our investigations, there has as yet been no comparison of the details brought out by the two methods of examination, except in a general way. It is obvious, therefore, that all minor details should be omitted from this report, and the results of our investigations at this time kinds of dust, whereas many occupations imply the breathing of various forms, and the effects are the same in general but may vary in degree.

This report deals entirely with the roentgenologic aspect of the subject and is made at this time in an endeavor to aid in the more accurate roentgen diagnosis of pulmonary disease. The clinical and patho-

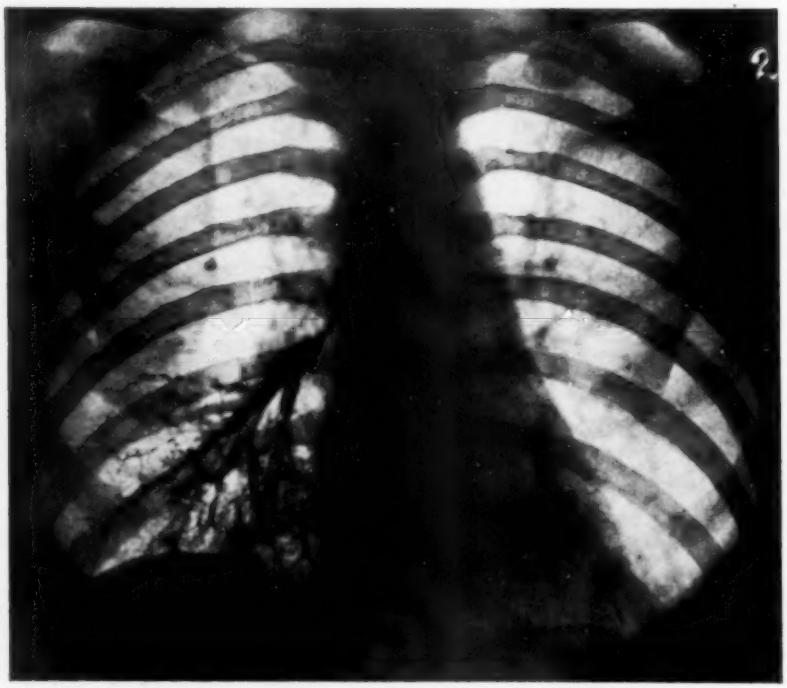

FIG. 1. OUTLINE OF THE LOWER PORTION OF THE BRONCHIAL TREE BY BISMUTH.

Chest of a young girl with supposed esophageal stricture, but in whom the supposed obstruction was merely neurotic in origin. The bismuth meal passed directly into the trachea and most of it descended into the right bronchus. Note the distribution of the lower branches. Dust inhalation does not seem to affect the outermost ones.

be limited to a statement of certain well-established general facts.

The entire subject is naturally to be regarded as a study of pneumoconiosis, a general term employed in referring to the effects induced in lung structure by the prolonged inhalation of abnormal quantities of dust. In a general study of the subject we have preferred to omit all reference to such terms as anthracosis, siderosis and chalicosis for the reason that they are indicative of the results of inhalation of certain

logic aspects of pneumoconiosis are by no means new, but thorough roentgenologic studies have been very few. Perhaps the most valuable contribution is to be found in United States Health Bulletin No. 85, issued January, 1917, comprising a clinical and roentgenologic study of 433 cases of "miners' consumption" among the zinc miners in Missouri, by Dr. A. J. Lanza, Surgeon of the U. S. Public Health Service and Dr. Samuel B. Childs of Denver. Another important contribution was made

FIG. 2. PNEUMOCONIOSIS IN METAL BALL GRINDER (DRY), SEVENTEEN YEARS' OCCUPATION.

The hilus shadows are greatly enlarged and linear markings are thickened, especially to the right base. There is intense mottling with small dense discrete spots on both sides, but more on the right.

FIG. 3. PNEUMOCONIOSIS IN POTTER, FORTY YEARS' OCCUPATION, SHOWING COMPARATIVELY LITTLE EVIDENCE OF DUST EFFECTS FOR THIS TIME.

The hilus shadows are slightly increased, linear markings thickened, and there is a moderate amount of discrete mottling most marked around the middle of each lung.

by Dr. W. W. Boardman in the June, 1917, issue of the AMERICAN JOURNAL OF ROENTGENOLOGY, dealing with cases of coal dust inhalation and reviewing the roentgenologic literature on the subject. Both of these were published while we were in the midst of our investigations, and it is interesting to note that the conclusions drawn by all of us, working independently, from the roentgenologic standpoint, have in the main been very much the same, differing only in minor details. Each of the above contributions has dealt with pneumoconiosis of a single origin, whereas we are endeavoring to study the condition as it arises from as many occupations as possible, and we have not, therefore, felt that our work conflicts with that of the other investigators. It has been proven by all that the roentgenogram, supplemented by a careful roentgenoscopic study, is by far the most accurate means of studying the effects of dust upon the lungs. The pathology of the disease has been well established by autopsy, and roentgen observations serve to accurately portray the exact conditions *in vivo*.

Practically all roentgenologists have had more or less opportunity to examine cases of pneumoconiosis, but most of these have been isolated examples of an advanced stage of the condition. In order to comprehend the various phases and to suspect and recognize them whenever seen and, most important, to differentiate the appearances of pneumoconiosis from those of other conditions, particularly tuberculosis, one must make a systematic study of the roentgen pathology through all the stages and from the standpoint of every source of

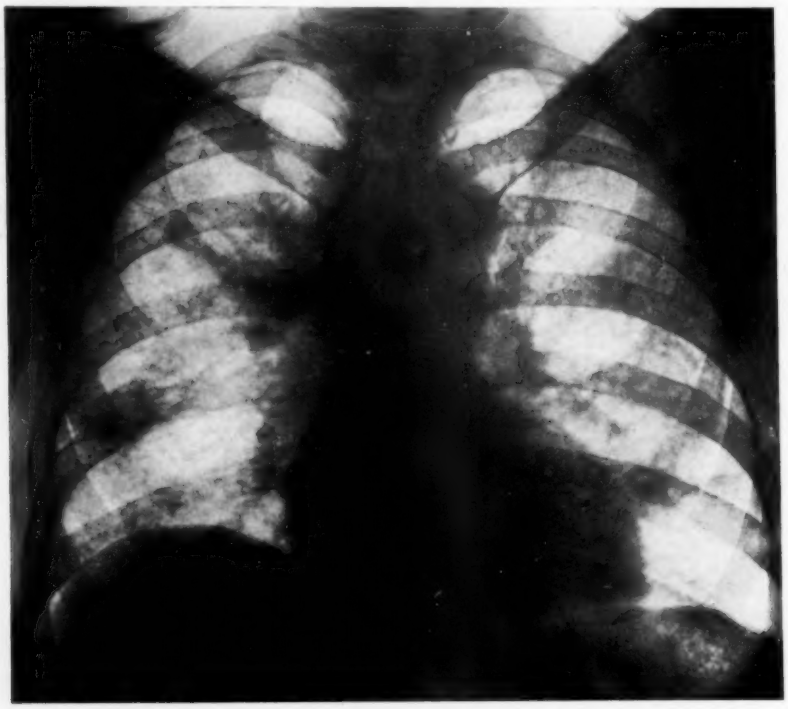

FIG. 4. PNEUMOCONIOSIS IN COAL MINER WHO WORKED THIRTY-EIGHT YEARS OUTSIDE THE MINES.

Roentgenoscopic examination: No interference with diaphragm excursion. Stereoroentgenograms: Increased hilus shadows, linear markings obscured, diffuse pneumoconiosis, with discrete spots, distributed from bases to apices, somewhat more marked on the right side where fibrosis is beginning. Note also the fibrosis in the subapical region. There were no unusual chest symptoms. This is a transitional case between the second and third stages.

invasion. When one realizes the very numerous occupations that provide sufficient dust to induce changes in the lungs, and the fact that dwellers in some large cities are subjected to sufficient dust to produce perceptible shadows in the lung structure, it seems quite probable that errors in diagnosis must be frequent unless the possibility of pneumoconiosis be constantly borne in mind.

FIG. 5. PNEUMOCONIOSIS IN COAL MINER WHO WORKED THIRTY YEARS INSIDE THE MINES.

Roentgenoscopic examination: Diaphragm almost fixed. Stereoroentgenograms: Extreme fibrosis of the third stage, with greatest density in subapical regions, where the density simulates consolidation. Emphysema at bases. Bronchiectasis left side. Intense dyspnœa. Repeated sputum examinations negative.

Three stages are to be recognized in the progress of the condition. In order to explain the condition itself and the changes which take place brief reference must be made to the pathology, which is very simple. The first marked effect of excessive dust inhalation is irritation of the air passages which amounts to a chronic bronchitis. This in itself is responsible for more or less fibrous change which becomes legible in the roentgenogram as a thickening of the trunk shadows. This is no doubt also due to a certain amount of dust deposition in the cells and neighboring lymph structures. The thickened trunks and the lymphatic structures with increased density tend to increase the size and density of the hilus shadows. Added pigmentation of cells and increased depositions of dust particles in lymphatic structures further out along the branching systems of the air passages gradually produce small areas of such density as to be visible and give to the lungs the characteristic mottled appearance so common in advanced cases of pneumoconiosis. Our experience has shown that this density is more or less closely related to that of the dust inhaled, being least in organic dust and greatest among metal grinders. Naturally the fibrous change that starts early from irritation increases, and there is later a decided fibrosis following up the deposition of dust. This seems finally to involve a large part of the lung

structure and is no doubt responsible for the dyspnœa by rendering the lung inelastic, which is readily determined by the lack of expansion noted by the fluoroscope, and particularly in the diaphragm. Bronchiectatic cavities are quite common in the late stages, and a similar process is manifest in the ultimate divisions of the passages as usually prominent trunk shadows, and an undue prominence of the finer linear markings. This is due to the causes just mentioned. It is the rule that the increase in thickness of bronchial trunk shadows is fairly uniform, which is the main dependence in distinguishing the case from one of peribronchial tuberculosis, but there are

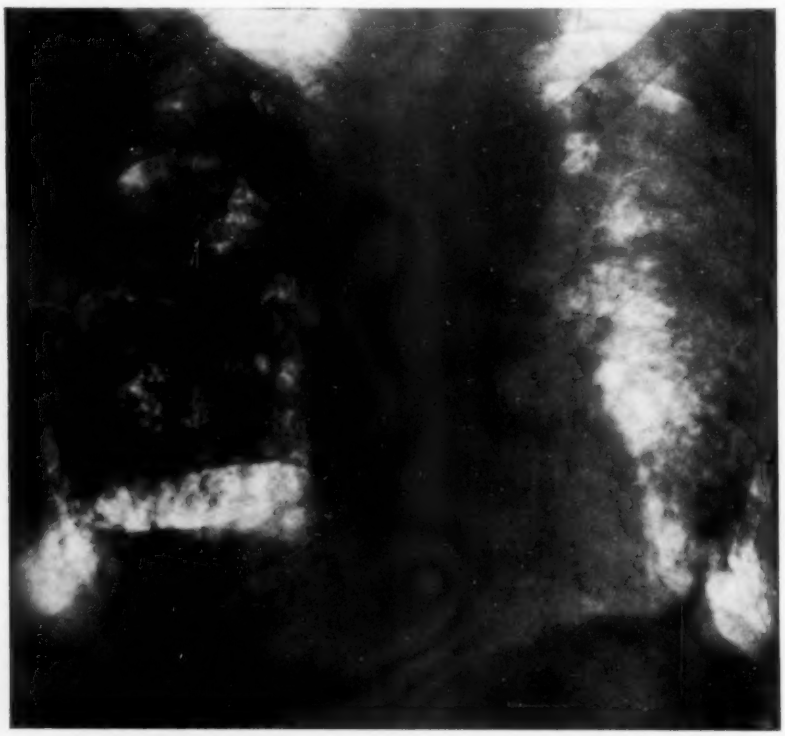

FIG. 6. PNEUMOCONIOSIS IN POTTER, FORTY-FIVE YEARS' OCCUPATION.

Roentgenoscopic examination: Almost complete fixation of diaphragm (intense dyspnœa). Stereoroentgenograms: Hilus shadows increased; linear markings obscured; emphysema bases; dense mottling becoming conglomerate, especially toward apices; extreme diffuse fibrosis, with bands to diaphragm, and heart and vessels drawn to the left; bronchiectatic cavities both subapical regions. Repeated sputum examinations negative.

emphysema. The division of the process into three stages seems to be a foregone conclusion among those who have made a study of the subject. Before any access to literature could possibly modify our views, we had made practically the same classification which has been presented by the authors already referred to.

The first stage, roentgenologically speaking, is characterized by an increase in the hilus shadows and a thickening of the exceptions, and it is these which makes the roentgenologic diagnosis difficult or uncertain. Boardman aptly calls attention to the fact that roentgenologists have no doubt been mistaking early evidences of pneumoconiosis for tuberculosis. If the distribution of the thickening is irregular, as it frequently is, and the trunks to one apical region only are involved, the two conditions are quite difficult to distinguish by the inexperienced observer, and often

almost impossible to differentiate by even the most experienced. A still more difficult problem is the detection of a peribronchial tuberculosis in the presence of evidences of the first stage of pneumoconiosis. In several instances we have recorded our plate readings as suspicious but we have not yet checked these up with the clinical findings. Abnormalities in the diaphragm

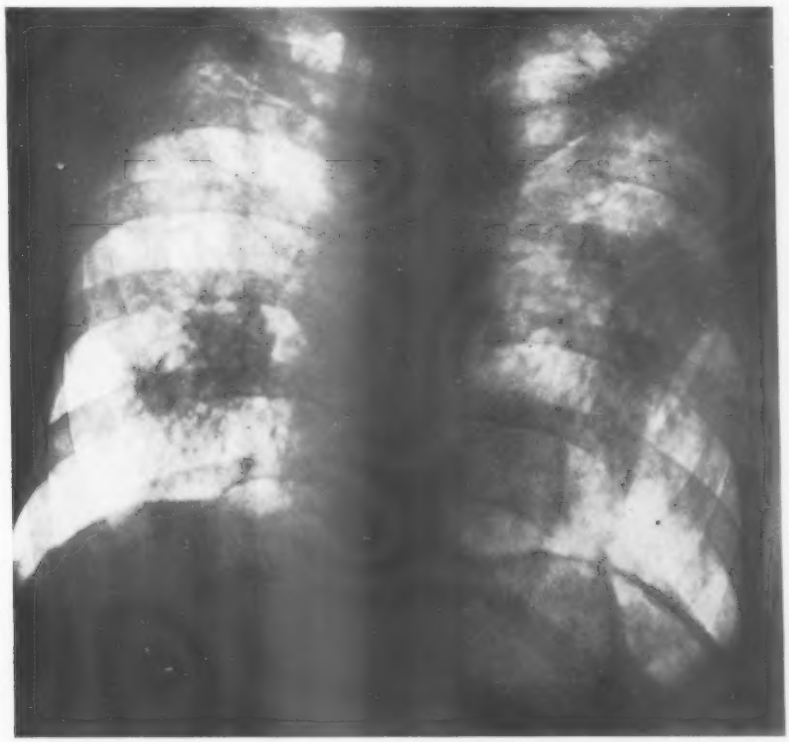

FIG. 7. PNEUMOCONIOSIS IN POTTER, FORTY-TWO YEARS' OCCUPATION.

Roentgenoscopic examination: Right diaphragm fixed at mid-point. Heart and vessels pulled to right. Emphysema at bases. Stereoroentgenograms: Hilus shadows and linear markings uncertain; dense mottling still visible but becoming conglomerate; extreme fibrosis in both apical and subapical regions. Repeated sputum examinations negative.

excursion are to be included in all the stages of the condition. We have certainly noted them in many instances in the first stage, contrary to the experience of Lanza and Childs. There is no general rule about them, however, in the first or even the second stages. When the excursion has been equally shallow on both sides in the first stage, we have frequently been unable to decide that this was not due to habit or to inability of many individuals of the labouring class to "show off" their diaphragms to best advantage. The position of the excursion during ordinary respiration between the limits of extreme inspiration and expiration is very variable. The most common finding was a restriction at the inner portion of the right diaphragm during full inspiration and either a decided flattening or a concavity of the outer aspect. It seemed as though the inner portion were halted in its descent by the process responsible for the thickened trunk shadows. It was our impression that the descending trunk shadows were usually more thickened on the right side than the left, but the interference offered by the cardiac shadow prevented a satisfactory proof of this supposition.

The second stage is characterized by a more or less uniformly arranged mottling

throughout the lung structure due to depositions of dust in the lymph structures, cells, and fibrous tissue interspaces, with the addition of a certain amount of localized fibrosis. This stage comprises what has usually been regarded as the typical case of pneumoconiosis. Its onset seems to depend largely upon the quality of the dust inhaled. It occurs comparatively early in coal miners, cement workers and certain metal grinders, somewhat later in potters and asbestos workers, and quite late in those inhaling organic dusts. The volume of dust will, of course, enter into the statistics of this aspect of our work, and while this has been measured by Dr. Miller, comparisons have not yet been made. In metal grinders it was quite noticeable that mottling was observed before the usual first stage appearances were well advanced. Cement, asbestos and carpet mills were the dustiest buildings examined by Dr. Miller, but no computations were made in coal miners. On the whole, it has been our experience that certainly quality and probably weight or density are more important factors in pneumoconiosis than quantity, contrary to the statement of Boardman. The distribution of the mottling is interesting. Invariably we have found it first appearing in the right lung, on a level with the hilus shadow, which is quite contrary to the statements of Lanza and Childs. It certainly becomes quite perceptible on the right side before it appears on the left, and for some time after it does begin on the left side, it is noticeably more marked on the right. Later on it is impossible to demonstrate any difference on the two sides. The distribution is more or less symmetrical, but naturally not uniform, throughout the lung. From the starting point it gradually spreads to the bases and apices, but is never so marked at the extreme apices or bases as around the mid portion of the lung. The appearance of the

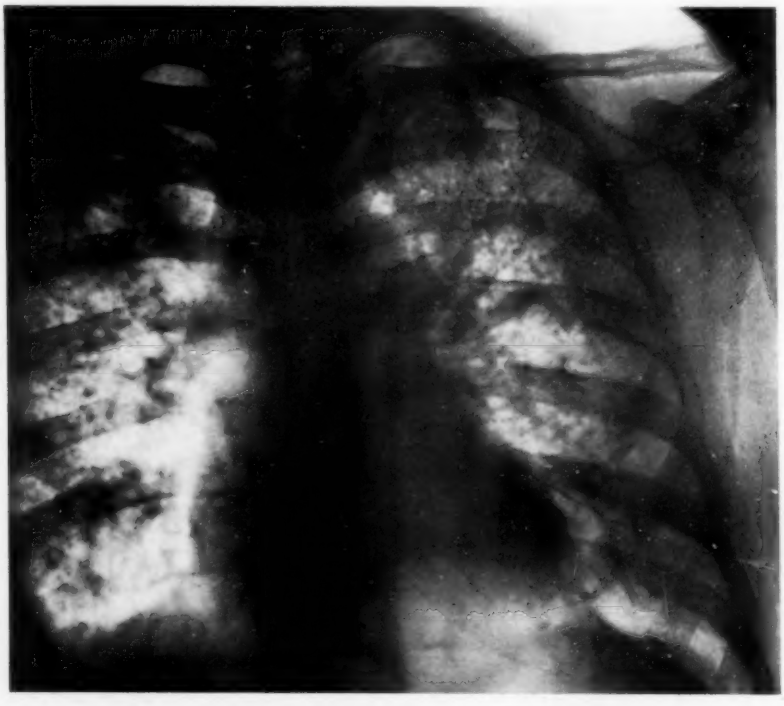

FIG. 8. PNEUMOCONIOSIS IN POTTER, TWENTY-NINE YEARS' OCCUPATION.
Dense mottling throughout both lungs. The appearance at the left apex suggests an associated tuberculous process.

FIG. 9. CHEST OF A MALE AGED TWENTY-NINE, WHO, WHEN A CHILD, INHALED A VEGETABLE BURR: RESULTING FIBROSIS.

The appearance is that of an extreme fibrosis which prolonged clinical study has proved not to be tubercular in origin. In the right base are numerous bronchiectatic cavities which, under the fluoroscope, could be seen opening on inspiration and collapsing on expiration. Compare this with fibrosis due to pneumoconiosis.

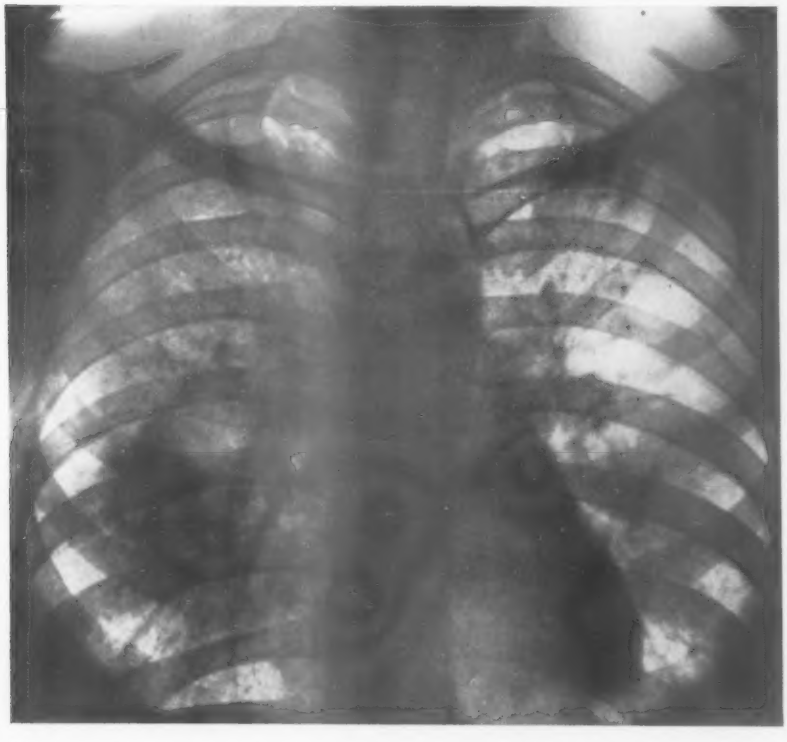

FIG. 10. OLD HEALED PULMONARY TUBERCULOSIS INVOLVING RIGHT LUNG, WITH RESULTING FIBROSIS.

Large bronchiectatic cavities previously found are now irregular in shape. The left lung is the seat of a more recent process now healed clinically. Compare with fibrosis due to pneumoconiosis.

mottling depends more or less upon the quality of the dust. In certain metal grinders the spots are very dense and sharply circumscribed and can be seen when very small. This is so to perhaps a less extent in coal miners, potters, and probably many other occupations. In cement and asbestos workers, among the inorganic dust occupations, the spots are noticeably softer and less sharply defined and the appearance is more like the early individual or conglomerate tubercle. In the organic dusts there is still further difference. Toward the end of the second stage the spots tend to enlarge and become conglomerate.

Errors in diagnosis are not so apt to occur in this stage. The appearance is so typical that no one is likely to mistake it for tuberculosis except possibly the miliary or bronchopneumonic types, and the history of the case is all that is necessary to correct any tendency to error. In a case examined without history, the distribution of the spots in the early stage and the comparatively slight amount of mottling in the apical regions later should put one on guard to ask questions. Here again, however, it may be exceedingly difficult to detect an early tuberculosis engrafted upon a well advanced case of pneumoconiosis in the second stage.

The third stage is the most interesting period in this condition from the roentgenologic standpoint. It is characterized by the appearance of diffuse fibrosis and all that the term implies. As an end result it does not differ greatly from the fibrosis that represents the terminal stage of chronic tuberculosis or some other less common causes. It is sometimes difficult to draw the line between the end of the second and the beginning of the third stage, and we are as yet uncertain as to the appearance at the period of transition. In some instances it would seem that the mottled appearance becomes increasingly conglomerate and passes over into the appearance of dense fibrosis, sometimes closely resembling consolidation. In other instances a general haze seems to spread over a certain portion of lung, resembling a thickened pleura in a flat plate but resolving itself into lung structure in stereoscopic plates. The greatest density is in the subapical regions, although this is not the region of most intense mottling in the second stage. We have imagined that the marked emphysema usually present at the bases must have some bearing upon this distribution. Dense fibrous bands can be seen extending in various directions, and frequently to the diaphragms, causing marked retractions. The heart and vessels are frequently dragged out of place. Bronchiectatic cavities are quite common. There is a very noticeable effect of inelastic lung structure upon respiration as studied by the fluoroscope. The ribs move little enough, and the diaphragms sometimes not at all. Is it in the least surprising that these unfortunate individuals suffer intensely from dyspnœa? In this stage the mottling has become extremely coarse and sometimes is to be no longer recognized as such.

The differential diagnosis between the fibrosis resulting from tuberculosis and pneumoconiosis is frequently a most difficult problem, and, we have had to acknowledge, sometimes well-nigh impossible. It has been hard to believe that some individuals have not had tuberculosis; but repeated sputum examinations, sometimes over a number of years, have been negative. Still more difficult frequently is the detection of a tuberculosis engrafted upon this stage of pneumoconiosis. Suffice it to say that our studies have convinced us that errors in diagnosis have been made with considerable frequency.

THE CLASSIFICATION OF PULMONARY TUBERCULOSIS, WITH A COMPARATIVE ANALYSIS OF THE DIFFERENT METHODS EMPLOYED *

BY F. H. HEISE, M.D.

and

H. L. SAMPSON

TRUDEAU, N. Y.

PULMONARY tuberculosis is a disease of such varied manifestations as to render classification of it upon any absolute basis almost impossible. Many attempts have been made by many men both independently and in collaboration to establish some method of classification which would be generally useful, not too cumbersome and at the same time would include most of the cases as usually seen. These attempts have been based upon the various aspects of the disease or upon a combination of the aspects. Thus we find [1] classifications based upon the following:

1. Origin of the disease (Hereditary, congenital, acquired).
2. Temperament of the patient (Erethismic or torpid).
3. Age (Infantile, developmental, adult, senile).
4. Dyscrasias (Gouty, scrofulous, diabetic, alcoholic, luetic, hysterical).
5. Ease of diagnosis (Latent, larval, manifest).
6. Onset (Catarrhal, anæmic, dyspeptic, pleuritic, hemoptoic, febrile, nervous, dyspneic).
7. Course (Active, stationary, progressive; remitting, intermitting, retrogressive; acute, subacute, chronic).
8. Extent of lesion (Circumscribed, disseminated or diffuse; incipient, limited, moderately extensive, advanced).
9. Pathologic changes (Consolidation, softening, cavity formation; germination, conglomeration, softening, cavity formation; parenchymatous, interstitial, bronchitic, postpleuritic).
10. Degree of susceptibility (Decided, yielding, or lost organic resistance).
11. Secondary infections (Pure tuberculosis, stage of mixed infection, or phthisis).
12. Prognosis—in part (Phthisis incipiens, confirmata et desperata).

It can readily be seen from these that no one classification can be made to embrace all of the factors mentioned and at the same time not be too cumbersome or too complicated for general use and comprehension.

In 1887 Dr. E. L. Trudeau formulated a classification based upon pathology as determined by physical signs and upon the local and constitutional disturbances. With this as a basis the National Association for the Study and Prevention of Tuberculosis formulated its classification which has since been modified several times. The American Sanatorium Association classification has arisen from the National Association classification and has itself been modified. Both physical signs and symptoms are used as a basis and both the intensity and extent of the physical signs are taken in consideration. The classification of Turban based purely upon physical signs is generally employed in conjunction with the Sanatorium Association. So we speak of Incipient Turban I, Moderately Advanced Turban I, II, and so forth. Recently, Dr. Rathbun of Otisville has suggested an additional notation in classification based solely upon symptomatology. Absence of symptoms or the presence of

[1] *Brown, Lawrason.* The Classification of Pulmonary Tuberculosis, *Jour. Am. Med. Assn.*, Vol. LII, pp. 341-348.

* Read at the Eighteenth Annual Meeting of the American Roentgen Ray Society, New York City, September, 1917.

very mild ones would be noted by "a," moderately severe symptoms by "b," and severe symptoms by "c." Thus the classification would be fully noted as Moderately Advanced II, R. L. b, etc., meaning that the patient's condition is included under the term "Moderately Advanced" as explained in the classification; that he had physical signs to the extent of "II" as described by Turban and that one lobe of each the right and left lung showed evidence of the disease and that the patient furthermore had the moderately severe symptoms as mentioned under "b" in Dr. Rathbun's subdivision. Following are the terms and limitations of the classification as usually employed to-day by the sanatoria for tuberculosis.

EXPLANATORY NOTE

The classifications regarding the extent of disease on admission and condition on discharge are those adopted by the National Association for the Study and Prevention of Tuberculosis, in May, 1913, and govern all the terms used in this report.

The classifications and their definitions are as follows:

1. On Admission

These definitions indicate the furthest extent of disease and the greatest severity of symptoms that a patient can present and still belong to the stage defined. All patients beyond the incipient stage fall under the moderately advanced stage unless the physical signs and symptoms exceed those of the moderately advanced stage, when they should be classified as far advanced.

Incipient.—Slight or no constitutional symptoms (including particularly gastric or intestinal disturbance or rapid loss of weight). Slight or no elevation of temperature or acceleration of pulse at any time during the twenty-four hours.

Expectoration usually small in amount or absent. Tubercle bacilli may be present or absent.

Slight infiltration limited to the apex of one or both lungs or a small part of one lobe.

No tuberculous complications.

Moderately Advanced.—No marked impairment of function, either local or constitutional.

Localized consolidation moderate in extent with little or no evidence of cavity formation; or infiltration more extensive than under incipient.

No serious complications.

Far Advanced.—Marked impairment of function, local and constitutional.

Marked consolidation of an entire lobe.

Or disseminated areas of beginning cavity formation.

Or serious complications.

Miliary Tuberculosis.

2. On Discharge

Apparently Arrested.—All constitutional symptoms and expectoration with bacilli absent for a period of three months; the physical signs to be those of a healed lesion.

Quiescent.—Absence of all constitutional symptoms; expectoration and bacilli may or may not be present; physical signs stationary or retrogressive; the foregoing conditions to have existed for at least two months. The length of time mentioned is of course somewhat arbitrary, but is intended to cover the cases which frequently occur, where the patients leave a sanatorium for various reasons, contrary to advice, after a stay of a few weeks, although all active symptoms may have ceased completely soon after entrance.

Improved.—Constitutional symptoms lessened or entirely absent; physical signs improved or unchanged; cough and expectoration with bacilli usually present.

Unimproved or Progressive.—All essential symptoms and signs unabated or increased.

Died.

3. Ultimate Results

Apparently Cured.—All constitutional symptoms and expectoration with bacilli absent for a period of two years under ordinary conditions of life.

Well.—Patients who fulfil all the conditions required under "cured" but about whose sputum no definite information can be obtained.

Arrested.—See "Quiescent" above.
Improved.—See above.
Progressive.—See above.
Dead.

DEFINITION OF TERMS

Terms Used in Definition of "Incipient"

1. *Slight Constitutional Disturbance.*—Slight loss of appetite, of strength, of weight; lassitude; possibly slight acceleration of pulse or possibly slight elevation of temperature. The impairment of health may be so slight that the patient does not look or feel sick in the ordinary sense of the word.
2. *Slight Elevation of Temperature.*—Maximum temperature after rest for one hour, never over 99.5° to 100° F. by mouth (or 100.5° per rectum).
3. *Slight Acceleration of Pulse.*—Maximum pulse rate not over 90 after rest for one hour, sitting or lying, except when due to causes other than tuberculosis.
4. *Absence of Tubercle Bacilli.*—Each monthly examination (if the sputum be negative) to consist of a careful microscopic examination, with a mechanical stage, of two smears, devoting at least three minutes to each smear, made from selected particles (at least six from different parts) of the sputum on each of three successive days. The morning sputum should always be obtained, or, better, the minute bits that some arrested patients raise at very infrequent intervals. It is not yet deemed wise to insist on digestion and centrifugalization or on inoculation of guinea-pigs.
5. *Infiltration.*—Physical signs of, slight prominence of the clavicle, lessened movement of chest, narrowing of apical resonance with lessened movement of base of lung, slight or no change in resonance, distant or loud and harsh breathing, with or without some change in the rhythm (*i. e.*, prolonged expiration), vocal resonance possibly slightly increased; or fine or moderately coarse râles present or absent. If sputum contains tubercle bacilli, any one of these.
6. *Apex.*—That portion of the lung situated above the clavicle and the third vertebral spine.
7. *A Small Part of One Lobe.*—An area of one or two intercostal spaces, or an area not exceeding 60 to 80 sq. cm. in extent, according to the size of the patient.

Terms Used in Definition of "Moderately Advanced"

8. *Marked Impairment of Function, Either Local or Constitutional.*—Local: Marked dyspnea on exertion limiting seriously the patient's activity.
   Constitutional: Marked weakness, anorexia, tachycardia.
9. *Moderate Extent of Localized Consolidation.*—An area of one-half lobe or less, but may involve both apices; marked dulness, bronchial or decidedly bronchovesicular breathing; markedly increased vocal resonance; râles usually present. These signs are to be sharply limited as to area instead of gradually shading into normal physical signs.
10. *Evidence of Destruction of Tissue.*—Presence of tubercle bacilli or elastic fibers in the sputum or the presence of the physical signs of a cavity. There are no absolutely certain physical signs of cavity but a combination of any four of the following signs is to be taken as indicative of a cavity: (1) cracked-pot note; (2) amphoric breathing; (3) intense whispering pectoriloquy; (4) a veiled puff or post-tussive suction; (5) bubbling or resonant râles. "Physical signs of softening" do not admit of any definition apart from that of cavity formation, and the term should not be used.
11. *Disseminated Fibroid Deposits.*—More or less localized areas of fibrous tissue, producing on physical examination some change or dulness in the percussion note, more or less increase of vocal resonance, harsh, suppressed, or bronchovesicular breathing, râles sibilant or sonorous usually, but at times fine and moderately coarse.
12. *Serious Complications.*—These should be limited to tuberculous complications, such as meningitis, pharyngitis, laryngitis (except slight thickening of the posterior interarytenoid space, and superficial ulceration of a vocal cord), enteritis, peritonitis, nephritis, cystitis,

orchitis, adenitis (unless very slight), etc.

TERMS USED IN DEFINITION OF "FAR ADVANCED"

13. *Marked consolidation* indicates dulness merging into flatness, bronchial or tubular breathing and other signs of consolidation as defined in Paragraph 10.

TERMS USED IN DEFINITION OF "APPARENTLY ARRESTED"

14. *Constitutional Symptoms.*—These include elevation of temperature, loss of weight, loss of strength, night sweats, chills, tachycardia, cyanosis, loss of appetite, amenorrhea, etc.

15. *Physical Signs of a Healed Lesion.*—These may embrace every physical sign of infiltration or consolidation (see Paragraphs 6, 10), with the exception of râles, which must be permanently absent, except possibly a few fine râles at the base, probably atelectatic in origin, and at one apex or over a small part of one lobe. Râles in the latter two places are to be heard only during the cough, at the end of a prolonged expiration, or during the inspiration which follows the cough.

TERMS USED IN DEFINITION OF "IMPROVED"

16. *Constitutional Symptoms Lessened or Entirely Absent.*—By this is meant an improvement in the general condition as shown either by a gain in *both* weight and strength or by reduction of previous febrile temperature to normal without loss of strength.

TERMS USED IN DEFINITION OF "UNIMPROVED OR PROGRESSIVE"

17. *Essential Symptoms and Signs.*—These include, among others, weight, strength, appetite, night sweats, hemoptysis, pleurisy, dyspnea, temperature, pulse rate, dulness, changes in vocal resonance and respiratory movement, râles.

TERMS USED IN DEFINITION OF "APPARENTLY CURED"

18. *Ordinary Condition of Life.*—This term as used implies that the patient is able to live in an environment where he is able to support himself without the assistance of others, or to live in his former surroundings and pursue his former occupation.

Using the above classification we have recently compared the findings upon roentgen ray examination, classified according to type into peribronchial and parenchymatous and according to extent into 1, 2, 3, 4, the unit being one half of one lung field. In addition, such individual symptoms, physical signs and laboratory findings as would in themselves aid materially in diagnosis were likewise compared with the roentgen ray findings, with the following results, in a series of 235 cases, examined by the same examiner and of all of which stereoscopic plates were taken.

A. COMPARISON OF CLASSIFICATION BY PHYSICAL SIGNS WITH COMPARISON BY ROENTGEN RAY

1. A positive history of tuberculosis was obtained in 19 cases in which the physical signs were negative or doubtful. Of these, 16% gave negative or doubtful roentgen ray findings and 68% showed a definite peribronchial lesion. Parenchymatous lesions were found in 16%.

2. Of the incipient cases (78), negative roentgen ray findings were obtained in 9%, peribronchial evidence in 42% and parenchymatous evidence in 49%.

3. Of the moderately advanced and far advanced cases (120) 2% showed negative roentgen ray evidence, 8% showed peribronchial lesions and 90% showed parenchymatous lesions.

From this it is seen that in those cases having a history of tuberculosis with little or no physical signs a definite parenchymatous lesion can be demonstrated in over 10%, while the majority (50%+) will show evidence of the peribronchial type. The absence of physical signs, therefore, does not warrant a negative diagnosis or classification.

B. COMPARISON OF EXTENT AND LOCATION BY MEANS OF PHYSICAL SIGNS AND ROENTGEN RAY FINDINGS

1. The extent as determined by physical signs was the same as that determined by roentgen ray in 28% of cases.

2. The roentgen ray revealed a greater extent in 54%.

3. The physical signs showed greater extent in 18%.

4. Physical signs were present on one side or the other where the roentgen ray gave no evidence in 17%. [The physical signs in these cases were mostly found at the right apex and at the bases.]

5. In 6% the physical signs and roentgen ray evidence were on opposite sides. [In 5% the physical signs were on the right and the roentgen ray evidence on the left; and in 1% the reverse was found.]

From this comparison it is seen that the roentgen ray in the majority of cases reveals a more extensive lesion than is found by physical signs, and that in a fair percentage of cases (10%+) physical signs are present over regions where the roentgen ray shows no definite lesion. The comparison as to locality would also show that physical signs at the right apex are not always indicative of an existing lesion. This is particularly true in those cases in which the physical signs are not marked and in those cases in which râles can not be detected.

C. COMPARISON OF ROENTGEN RAY EVIDENCE AS REGARDS TYPE WITH THE OCCURRENCE OF DEFINITE AND CORROBORATIVE SYMPTOMS AND LABORATORY FINDINGS

1. Fever occurred at some time during the present illness in about the same percentage of cases of peribronchial and parenchymatous types (65%).

2. Pleurisy with effusion occurred in about the same percentage of peribronchial and parenchymatous types (8%).

3. Pleurisy without demonstrated effusion occurred in 48% of the peribronchial and 67% of the parenchymatous types [50% increase in the parenchymatous].

4. Streaked sputum [not accompanied by expectoration of ʒi or more of pure blood] occurred in 20% of the peribronchial and 25% of the parenchymatous cases [25% increase in the parenchymatous].

5. Hemoptysis of a teaspoonful or more occurred in 13% of the peribronchial and 42% of the parenchymatous cases [225% increase in the parenchymatous].

6. Fine râles were present in 17% of the peribronchial and 20% of the parenchymatous cases [19% increase in the parenchymatous].

7. Medium coarse râles were present in 3% of the peribronchial and 57% of the parenchymatous types [1800% increase in the parenchymatous].

8. In those cases having a peribronchial lesion on one side and a parenchymatous lesion on the other râles were present on the parenchymatous side in 62% and on the peribronchial side in 4% of the cases, while in 34% râles occurred on both sides [1450% increase on the parenchymatous side].

9. Tubercle bacilli in the sputum, found only before entrance to the sanatorium; this condition occurred in 8% of the peribronchial and 13% of the parenchymatous types [63% increase in the parenchymatous].

10. Tubercle bacilli found upon entrance to or during residence at the sanatorium: this occurred in 7% of the peribronchial and 65% of the parenchymatous types [828% increase in the parenchymatous].

11. Of the peribronchial cases included under number 10, one half showed Gaffky I with one or two bacilli found only once during residence. The other half showed Gaffky II or III found only once during residence.

12. The complement fixation test as done by Mr. Petroff showed a much higher percentage of positives in the parenchymatous than in the peribronchial types.

13. The intradermic skin test with O. T. gave a higher percentage of reactions to the weaker dilutions [0.00001 O.T. and under] in the parenchymatous types and a higher percentage of reactions to the stronger dilutions [0.001 O.T. and over] in the peribronchial types.

From this comparison it is seen that elevation of temperature without reference to character or degree gives no evidence as to the type of lesion to be found upon roentgen ray examination. This is also the case when pleurisy with effusion occurs.

However, when streaked sputum or hemoptysis occur, or when râles or tubercle bacilli are demonstrated, the type of lesion is more apt to be parenchymatous. This holds true to such degree as to warrant the classification into peribronchial and parenchymatous.

SUMMARY

The roentgen ray picture, properly taken, is of great value in the more exact classification of pulmonary tuberculosis. It will locate more definitely the seat of the lesion, often revealing one not detectable by physical signs, and failing to reveal one suspected by physical signs. The extent of the lesion is more accurately obtained by the roentgen ray than by any other available means and the character or type of lesion or pathology is much more correctly determined. Using the types peribronchial and parenchymatous as a basis for classification, it is seen that not all negative lung examinations made by physical signs denote an absent pathology, for in over 10% a definite parenchymatous lesion can be found whereas in over two-thirds of the above mentioned cases a peribronchial lesion can be detected.

The roentgen ray pictures would also show that not all incipient cases nor all moderately advanced cases have the same type of pathology; and what is more important in classification and prognosis than the type of pathology present?

The two types peribronchial and parenchymatous hold quite true to the clinical and laboratory findings, but the terms are not definite enough to signify extent and location; and in the case of parenchymatous the term does not signify sufficiently the characteristics of the lesion seen. It is very desirable that a more detailed classification should come into general use; one which would be practicable and not cumbersome and easy of interpretation. Your own president has been much interested in this subject and has offered a very good scheme for its accomplishment. To date no scheme has been adopted by the Sanatoria, and we would like to take the opportunity of presenting for your consideration a very incomplete but practical suggestion for classification by means of the roentgen ray. We would make use of the two terms peribronchial and parenchymatous and would denote extent and location in the following way. Any lesion not more extensive than the area of one interspace [15 to 20 sq. cm.] would be termed I, and any lesion greater than I but no greater than the upper ½ [root upward or 3d rib upward] of one lung field would be termed II. All lesions more extensive than II would be classified as III. The sides right and left to be indicated by the letters R and L. Thus upon complete classification we would have something like the following:

Incipient I R; Pb I R; a, or

Moderately Advanced II RL; Pc I R, Pb II RL; b, and so forth.

Of course this idea is offered merely as a suggestion in the hope that at some future date discussion may bring forth a workable and acceptable method of classification. This is sorely needed by all who practice in tuberculosis and especially needed to further the study of pulmonary tuberculosis about which we really know so little.

DISCUSSION ON PAPERS OF DRS. PANCOAST, HEISE AND CRANE.

DR. HENRY HULST, Grand Rapids, Michigan.—While I do not care to say anything now about the subjects treated by Drs. Pancoast and Heise because I did so a year ago in Chicago, I do wish to dwell for a moment upon the occurrence and the meaning of Dr. Crane's inverted comma.

I had almost forgotten about this sign, at least it had not entered my field of consciousness for a long time until Dr. Crane again called my attention to it a week ago when he came to Grand Rapids and asked me to get out my lung plates and look for the comma. We had not the time to look into this during his visit, but after he had gone I went over some one hundred and forty plates. I also looked over Dunham's Atlas. I found none in Dunham, though I am told there are several there, a fact of considerable psychological interest. In the one hundred and forty plates from my own collection I came across but one comma that was fairly prominent and not an illusion. Strange to say this occurred in an incipient case of tuberculosis in a young child, though Crane states that he has never found it in children.

Now I have no doubt that Crane's inverted comma is not an illusion. It must have an anatomical basis. The question remains, however, what can it mean? Accordingly, I consulted the third volume of Spalteholz's Hand Atlas of Human Anatomy. In Figs. 630 and 631 are illustrated the relations between septum mediastinale and pleuromediastinalis, the formation of the pleura pericardiaca and lamina mediastinalis. These viewed edgewise, when thickened and hardened from any cause, account, I think, for the inverted comma, especially if there happens to be involved a gland in the hilus. The left not being viewed edgewise but somewhat more laterally naturally does not show up so well or not at all. The presence of this sign, though not pathognomonic of tuberculosis, is evidence of disease and is well worth looking for.

DR. FREDERICK H. HEISE, Trudeau, N. Y.—After hearing Dr. Dunham's remark, I would like to say that, fundamentally, as Dr. Dunham knows, there is really no "disagreement in the family."

DR. FREDERICK H. HEISE, Trudeau, N. Y.—Dr. Dunham gave you, in a very lucid and detailed manner, the method of production of what we term the *peribronchial form* of tuberculosis. There is one thing, one fact, which is very evident to those who specialize in tuberculosis, and that is, that nodular shadows which are peribronchial in distribution are not all proven to be tuberculous.

DR. FREDERICK H. HEISE, Trudeau, N. Y.—In approximately 30 per cent of all cases sent to us we find peribronchial lesions, and we send back quite a few of those as not having clinical tuberculosis—that is, we cannot prove they have it. And we use the most up-to-date and comprehensive methods to prove that they have. In other words we keep a patient until, by all the means available to us, we fail to prove that he has active tuberculosis, before we send him away. Nevertheless, as Dr. Dunham has said he believes, there is a peribronchial form of lesion occurring in patients with symptoms which are almost undeniably symptoms of tuberculosis.

DR. FREDERICK H. HEISE, Trudeau, N. Y.—So there is no difference or argument, you might say, in the family. That brings out the point which I mentioned in my last paper and which I am so pleased to hear has been taken into consideration by this military report: that is, the fact that there must be coördination between the symptoms, the physical signs, and what we see on the *x*-ray plate. There must be coördination, for tuberculosis is a disease; and disease means something which alters the individual constitution

in an unfavorable way. It makes the patient sick. On the other hand there are patients who have not been ill but who have, to my belief, evident tuberculosis, which cases, as Dr. Dunham and Dr. Cole rightly say, should not go into the Army.

However, it has been my experience recently—when examining (by both the stethoscope and the plate methods) men who have been at Plattsburg, and in a few instances men who have gone through seven months of intensive training or have seen service on the border—to find that they have definite parenchymatous lesions, apparently recent infections, down fully to the second or third rib on one or both sides. If I am correct, a certain proportion of the men showing this condition have been sent to the front. It would be interesting to know whether these men will eventually relapse when they have both the physical and mental strain of warfare.

COMPARISON BETWEEN CLINICAL AND ROENTGENOLOGICAL FINDINGS

IN the Section on Diseases of Children of the 68th Annual Meeting of the American Medical Association, Dr. Henry Dwight Chapin read a very timely and instructive paper on the above subject, the importance of which lay in the fact that the interdependence of the clinical and roentgenological methods of diagnosing pathological conditions in infants and young children is illustrated with peculiar emphasis in diseases of the chest.

Aside from the difficulty of keeping these little patients quiet during the exposures which might easily result in exaggerated heart shadows in any direction, Dwight Chapin enumerated a number of other instances where differences have been observed between the results of the two methods of examination, and the *Medical Record* for June 9, 1917, contains a summary of the author's paper from which we learn the following:

A comparison was made in fifteen cardiac cases between the roentgen ray findings and the result of physical examinations. Seven of the cases showed an agreement, one partly agreed, and seven failed to correspond in the conclusions reached by those two methods of examination. The interpreter of the roentgenograms considered that an early mitral lesion caused accentuation of the normal left auricular and pulmonic curves, producing a spherical or rounded appearance. It was difficult to distinguish by heart shadows mitral stenosis from insufficiency when either were present in only a moderate degree. In regard to the lungs the combined study of the physical signs and roentgen ray pictures was made in ninety-seven cases, with a substantial agreement in seventy-seven and disagreement in twenty of the cases. As examples of the latter, five gave roentgen ray evidence of lobar pneumonias that were not detected by physical signs; two gave physical signs of lobar pneumonias which were not confirmed by the roentgen ray; three showed physical signs of bronchopneumonia not exhibited by the roentgen ray. As a general rule it was found that the roentgen ray would often give a showing in the absence of physical signs in congestion, small consolidations, hilum infiltrations, intralobar pleurisy, miliary tuberculosis, and mediastinal tumors. The difficulty in diagnosing hilum infiltrations and enlarged nodes was very great, and here the roentgen ray was very helpful. A study of the transmission of voice sounds below the seventh cervical vertebra, known as d'Espine's sign, in connection with the roentgenograms made in eighteen cases of children gave the d'Espine sign from the second to the fourth dorsal vertebra. The comparison here made showed that d'Espine's sign had considerable diagnostic value in diseased conditions at the root of the lung. Another point emphasized was that in all cases central pneumonias were peripheral pneumonias and that all so-called central pneumonias started at the periphery of the lung.

THE AMERICAN JOURNAL OF ROENTGENOLOGY

PUBLISHED BY PAUL B. HOEBER, NEW YORK CITY

Issued Monthly. Subscription, $5.00 per year. Advertising rates submitted on application. Editorial office, 124 Manchester St., Battle Creek, Mich. Office of publication, 67-69 East 59th Street, New York

OFFICIAL ORGAN OF
THE AMERICAN ROENTGEN RAY SOCIETY

President

W. F. MANGES, M.D.,
264 S. 16th Street, Philadelphia, Pa.

First Vice-President

H. W. VAN ALLEN, M.D.,
19 Maple Street, Springfield, Mass.

Second Vice-President

H. M. IMBODEN, M.D.,
480 Park Avenue, New York, N. Y.

Secretary

WILLIAM H. STEWART, M.D.,
222 W. 79th St., New York, N. Y.

Treasurer

WM. A. EVANS, M.D., 32 Adams Av., W., Detroit, Mich.

Executive Committee

DAVID R. BOWEN, M.D.,	Philadelphia, Pa.
HOLLIS E. POTTER, M.D.,	Chicago, Ill.
L. JACHES, M.D.,	New York, N. Y.

Publication Committee

P. M. Hickey, M.D.,	Detroit, Mich.
GEORGE C. JOHNSTON, M.D.,	Pittsburgh, Pa.
A. W. CRANE, M.D.,	Kalamazoo, Mich.

Librarian

H. W. DACHTLER, 224 Michigan St., Toledo, Ohio

Editor

JAMES T. CASE, M.D., F.A.C.S., Battle Creek, Mich.

Associate Editor

A. W. CRANE, M.D., Kalamazoo, Mich.

EDITORIALS

THE PRINCIPLES OF LOCALIZATION

It is a matter of medical history that one of the first uses to which the roentgen rays were put after the announcement of their discovery in December, 1895, was the localization of foreign bodies. The principles of localization which are being utilized today, in a great multiplicity of procedures bearing the names of the individuals who published them, are the same principles which were evolved and published within the first few years after Roentgen's original publication. For instance, the method of making two plates at right angles was employed in 1896 by Brissaud and Londe, in a case of a projectile in the head. In January, 1897, Mackenzie Davidson and Hedley began their publications on the "cross-thread" method which forms the basis for so many of the methods bearing more modern names. Remy and Contremoulins, in 1897, recognizing the elements of error in the methods then employed, published a description of their *compas*, an instrument of precision. In the same year Leduc published a description of the screen methods of localization. Some one has estimated the number of localization methods which have been published up to date as exceeding two hundred; yet it may be said of practically all of them that they fall into one of the classes of methods described in the beginnings of roentgen ray work. For these reasons it will be the policy of this journal to avoid as much as possible reference to names of individuals in describing methods, giving preference to such terms as "the cross-thread method," "the parallax method," etc.

One should not infer too quickly that the author of a so-called new method intentionally retreads ground gone over by his predecessors or by his *confrères*. It is not always easy for the roentgen ray worker in a military hospital, in his sometimes much isolated position, to keep in touch with the literature; and unless the editors watch carefully, slips will occur, and localization methods will be rediscovered and republished. There was recently a reference in these columns to a device of Dr. Young, for the utilization of the parallax method of localization. The editor is personally convinced from first-hand informa-

tion and personal observation that the instrument described by Young entirely originated with him; yet investigation of the literature shows that the same method was previously described and the same instrument pictured in an article by Le Faguays (*Journal de Radiologie*, 1915, p. 711).

As a matter of fact, the natural tendency of any one with a mechanical turn of mind placed in a large hospital, and confronted with the necessity of rapid and reasonably accurate localization of foreign bodies, will be to devise short-cuts. Even the beginner in military roentgenology will be tempted to put his mind on working out some, entirely new to him, mechanical device for shortening the time and labor incident to localization operations. Our advice to all is that they shall familiarize themselves with as many as possible of the multitude of methods which have been born of the great war, which, although to us only in its first months, is well along in its fourth year. Before putting any time on a strange or new method suggested, it would be well to perfect one's self in the approved and accepted means.

There will shortly be published from the Surgeon General's Office, and we hope also in these columns, a digest of the localizing methods which have been accepted and approved as the preferred procedures for use in the United States Army Medical Service. It is only after a great deal of study and personal observation that we have been able to decide on a few methods as being standard. As our esteemed French *confrère* Ledoux-Lebard says, "We do not lack procedures; rather the opposite. Such a large number of methods of localization have been described since the war that we should be greatly embarrassed to make a fair selection between them if we had to acquire the necessary practice with each, because the days of our life would not be sufficient for the purpose. . . . Among the recent publications there are many old and well-known procedures which have been re-edited under a new name. These regrettable errors are largely committed by roentgenologists who have been improvised since the beginning of the war and who . . . honestly believe that they have 'discovered' something unknown in roentgenology. But they are to some extent excused by the extreme difficulties of a scattered and largely inaccessible bibliography."

J. T. C.

The *X*-Ray Diagnosis of Pulmonary Tuberculosis

In recent books and current periodicals will be noticed a strong tendency to discredit the *x*-ray diagnosis of pulmonary tuberculosis. This is deserving of attention because the authors in many instances are internists of unquestionable standing. Surprise and resentment are the first feelings of the roentgenologists. But this tendency is not without foundations.

Almost universally we find the assumption on the part of internists: (1) That the roentgenologist claims to present a complete exposé of pulmonary conditions and (2) that tuberculosis shows on the plate certain specific signs pathognomonic of the disease. They may be pardoned for this assumption because it is true that the roentgenologist is very likely to give, not an interpretation of *x*-ray findings, but a diagnosis of disease.

The same contest which we see between roentgenographic and physical methods was once waged between laboratory and physical methods. Indeed the smoke of battle is yet visible in the medical atmosphere. We may recognize and even admire the pride of craft which leads the skillful internist to guard with jealous care his diagnostic province, but we believe that this attitude is fundamentally wrong. The *x*-ray is a part of the physical examination, not a method to supplant it; it is an extension of our faculties of right, not a substitute for the auditory or the tactile sense; it is an analysis of different tissue densities, not a chemical reaction; and it records certain gross pathologic changes

but does not seek to usurp the microscopic slide or the culture tube.

While the *x*-ray diagnosis of fractures and foreign bodies is final, the *x*-ray diagnosis of internal disease should rarely be attempted. Likewise a laboratory, a physical or a symptomatic diagnosis is rarely admissible. Occasionally brilliant feats of interpretation and intuition are achieved by the use of a single method just as a musical score has been executed upon a single string of a violin or a phenomenal run made by a one-armed billiard player. But *x*-ray diagnosis, even in such apparently clean-cut cases as renal stone, aneurism or osteosarcoma, demands a correlation of clinical data to avoid a repetition of the humiliating mistakes that are on record.

However, papers and discussions before this society have so often emphasized the interdependence of different lines of diagnostic data that it seems a matter of supererogation to elaborate upon this point. We would ask that writers recognize the attitude of representative roentgenologists towards the correlation of the case history, physical examination and laboratory analyses, with the *x*-ray findings.

With this attitude of mind we come to the question of *x*-ray findings in pulmonary tuberculosis. The roentgenologist and the internist are peculiarly alike. Neither is able to distinguish pathognomonically between the tuberculous and the non-tuberculous, to detect infallibly the first signs of incipient disease or to decide unequivocally between the active and the quiescent lesions. But given physical signs and we can demonstrate the exact extent of the pulmonary involvement; given a positive Wassermann and we can define the location of each luetic focus in the lungs; given the history of primary carcinoma and we can show the first signs of thoracic metastasis;—all with a precision unapproachable by clinical methods alone. The roentgen analysis is quantitative rather than qualitative and the roentgen map is accurate for boundaries but indefinite for specific names.

Are we yet to learn new signs, can we find new meanings in old signs or have we reached the limitations of plate and screen?

In the privacy of our own minds we may be as theoretical and hypothetical as we please. If we were to assume the same privilege in the editorial columns we might suggest a number of lines of research which, as is often the case with hypothetical suggestions, may be barren of results.

In the recognition of incipient tuberculosis and to distinguish between an active and a quiescent case, why should not the serial plate method be used? It obviously cannot be the rapid serial used in gastric and duodenal roentgenology. It must be more akin to the cinematographic serials of plants. If a growing flower can be made to expand before our eyes why cannot a progressive lung lesion be similarly demonstrated? The objections are the number of plates required and the length of time during which the patient is losing valuable ground. But in the case of pulmonary lesions it is solely the point of progression that is to be demonstrated. And a few plates only, possibly of circumscribed areas would suffice. As for the length of time required we must appreciate the fact that the methods of the internist in similar cases are essentially serial. He takes serial temperature and pulse records. He repeats for days, weeks or months his physical examinations. It is only in the well-marked case or in one where tubercle bacilli can be found in the sputum that he can reach a decision from a single interview. And yet the roentgenologist is expected to reach his decision from a single examination. As well make an instantaneous photograph of an automobile to determine whether or not it is moving as to make an instantaneous plate of the chest to show whether or not the lesion is progressive. To be sure clever inferences can be made in both cases.

We have, it is true, ignored the whole subject of specific signs which various authors describe as distinctive of the progressive lesion. The peribronchial inflam-

mation, the smoke cloud, the fan and linear markings, the pleuritic effusion, the indefinite borders of a consolidation and the absence of calcified foci are unquestionably significant. These are all signs which are the exclusive property of the *x*-ray plate, excepting the pleuritic effusion, and the certainty with which pleuritic fluid, whether pocketed or free, can be located or excluded by the *x*-ray finds no parallel in other clinical methods. The sole advantage of the exploring needle, albeit a mighty one, is its portability, but the frequency of the dry-tap and the attitude of the patient towards repeated insertions of the needle, are indices of its disadvantages.

The valuable work of Dunham in conjunction with Miller on the architecture of the lung with special reference to the lymph channels is of fundamental importance to the interpretation of the chest plates. We have in the work of Pancoast, Childs and others a differentiation of pulmonary changes due to dust inhalation with inorganic deposits. The inverted comma sign is an example of a recurring shadow of definite form and position, yet to be fully understood. The studies of calcification processes in the human body have been shown to be matters of unexpected complexity and are of particular moment in pulmonary roentgenology. These are but few of the indications that pathology is being rewritten in terms of roentgenology.

For healed lesions we have a positive sign, a calcified focus without a nebula. But unfortunately a lung may show a healed lesion in one part and an active lesion in another. Calcified foci do not mean immunity and healed lesions may light up anew. A tuberculous deposit in a chest is like a mine with a fuse—we do not always know whether or not it is burning.

Another suggestion is that the hilus cluster of shadows should be carefully charted in hopes that definite figures will recur to which some significance may be attached. The inverted comma sign is a differentiation in this direction. The hilus cluster, the pulmonary pleiades, like a swarm of foci tangled in lymphatic braid, is at once the hope and despair of the roentgenologist. It is here that he must look for the first signs of pulmonary infection. The lymphatic system of the lungs and lower bronchi and the upper abdomen drain mostly into these nodes. Dust particles as well as bacteria find lodgment here. The normal hilus of age would be pathologic for youth. The pulmonary history of each individual is here permanently recorded. It remains for us to decipher the hieroglyphics.

Yet another suggestion is a refinement of team-work between the internist and his natural consultant, the roentgenologist. When in a stereoscopic set of plates one or more lines of increased density can be traced from hilus to periphery, the exact location of the chest-wall endings may be marked on the patient. At this particular point the internist should place his stethoscope and listen for the oscultatory signs of active lesions. Along this line of density may be transmitted delicate sounds from the interior of the lung and from the hilus.

However these things may be, we must learn new signs, we must find new meaning in old signs and we must have faith that the limitations of tube and screen are still beyond human ken.

A. W. C.

TRANSLATIONS & ABSTRACTS

FISHBERG, MAURICE. Localized and Interlobar Pneumothorax Complicating Pulmonary Tuberculosis. (*Arch. Int. Med.*, November 15, 1917.)

Certain complications in active pulmonary tuberculosis often escape detection unless all diagnostic aids are applied. Latent, partial and interlobar forms of pneumothorax are frequent, but only rarely recognized. The differentiation between these and pulmonary cavities is of importance in prognosis. It was this class of localized and interlobar pneumothorax cases which gave the first impulse to treat certain phthisical patients by the induction of pneumothorax. The roentgen ray has made the difficulties in diagnosis less, but even now it is sometimes impossible to differentiate. Pneumothorax with complete collapse of the lung is usually easily recognized. Acute symptoms, such as pain in the chest and dyspnea, may sometimes indicate the diagnosis. Some cases of localized pneumothorax run an acute course and are rapidly fatal. Case 1 was of this class. The clinical findings and the roentgenogram both indicated localized pneumothorax. Some forms are latent and after a stormy onset, the patient may feel well and show improvement. Case 2 was of this sort. Although the physical findings were ambiguous, the diagnosis of a localized pneumothorax was made. The roentgenogram confirmed this. Case 3 was of a similar nature. Cases 4 and 5 simulated cavity very closely, but were diagnosed to be pneumothorax. Case 6 was a case of pulmonary cavity cited to show that the average case is easy of diagnosis with or without roentgenographic examination. At times the clinical and roentgen findings are at variance. Case 7 was a case in which the roentgenogram showed distinct signs of a localized pneumothorax. Clinical signs were in favor of a cavity. Necropsy confirmed the clinical findings. Case 8 was a similar case in which the clinical and roentgen findings were at variance. The clinical findings were proved correct by necropsy. These two cases illustrate the fact that while roentgenography is an indispensable aid in diagnosis and in differentiating pathologic changes in the thoracic viscera, yet it is apt to prove misleading. Cavitary cases may sometimes be demonstrated by a series of plates taken under various conditions. The changes due to accumulation and emptying of secretions may be of diagnostic importance.

Discussion.—Localized and interlobar pneumothorax cases are frequent and are often diagnosed as cases of pulmonary excavation. These cases are found much more often since the introduction of the roentgen ray as a diagnostic aid. The mode of onset is important. Sudden onset points toward pneumothorax. If the sudden appearance of pain in the chest is not found to be due to pleurisy or myocarditis, a thorough examination should be made. Differential points are: In localized pneumothorax the cavity is "dry." Large excavations usually show large, moist, consonating râles and gurgles. The breath sounds in pneumothorax are amphoric or metallic. In some cases of pneumothorax a metallic tinkle is heard; in cavities rarely. Auscultation of whispered voice sounds is of great importance. In cavities whispered pectoriloquy is frequently absent, while in pneumothorax it is commonly present and is strikingly pronounced. This is distinctly heard high in the axilla. Over cavities, as a rule, the percussion note is dull. In pneumothorax, tympany is more frequently elicited. Cracked-pot resonance and Wintrich's sign are more frequent in cavities. Retraction of the chest wall is characteristic of large cavities, while bulging may be found in localized pneumothorax. The location of the mediastinal organs gives no reliable clue as to the true lesion. The roentgenographic findings are invaluable in most doubtful cases. A bright circumscribed area lacking in lung markings, when not surrounded by a thick dark shadow, is pathognomonic of a localized pneumothorax. On the other hand, the walls of the pulmonary cavity may not cast a shadow on the roentgenogram. In such doubtful cases fluoroscopy may be of more value than roentgenography.

John B. Jackson

GAUVAIN, H. J. Heliotherapy and X-Rays in the Treatment of Surgical Tuberculosis. (*Lancet*, CXCII, April 28, 1917, p. 653.)

At a meeting of the Royal Society of Medicine, Section of Electrotherapeutics, which was held on April 20, Gauvain entered into

considerable detail on the favorable effect of sunlight in surgical tuberculosis which acted not only on the superficial lesions but also indirectly on the constitution, thereby increasing the resistive power of the patient.

The second part of his paper was devoted to the indications for roentgen treatment under like conditions. The importance of careful technic and selection of suitable cases was emphasized under strict observance of Iselin's table of tolerance. The author summarized his observations as follows:

(1) Roentgen treatment is of great help in certain local conditions, and in conjunction with general improvement the local benefit derived is often maintained.

(2) The value and applicability of the rays vary in different parts of the body.

(3) Roentgen rays are useful in certain cases of sinus formation and in the treatment of many tuberculous ulcers, leaving supple non-keloidal scars.

(4) Roentgenotherapy is especially valuable in certain cases of tuberculous adenitis, but the greatest benefit may usually only be anticipated in conjunction with other methods of treatment: it is particularly useful where there is much periglandular infiltration, and here forms a useful treatment preliminary to extirpation or aspiration. The latter, with the use of modifying fluids, is preferable to extirpation under opportune conditions.

(5) Roentgen rays are most safely applied in the neck, elbow-joint and knee-joint.

(6) Roentgenotherapy is apparently helpful in certain cases of caseous abscess formation.

Contraindications to the use of the roentgen rays in the treatment of surgical tuberculosis are summarized as follows:

(1) Roentgen treatment is unnecessary and undesirable in abscesses which can be easily aspirated, and they should not be used in abscesses which leak from an aspiration puncture resulting from faulty technic.

(2) The application of roentgen rays is dangerous in abdominal tuberculosis and apparently of little value in costal tuberculosis.

(3) There may be untoward effects as the result of careless technic or too frequent exposures.

In conclusion the author lays stress upon the fact that, while roentgen rays are of great assistance in specific lesions, other aids are often required and should be associated.

GEKLER, W. A. Phthisis Pulmonalis and Other Forms of Intrathoracic Tuberculosis. (Abstract of paper read before the Chicago Roentgen Society, Jan. 12, 1917.)

The writer calls attention to the fact that tuberculous disease in the chest does not always manifest itself in the same manner. It is possible to differentiate roentgenographically as well as clinically between these different forms of tuberculosis.

The first form discussed was the primary tuberculosis of children, with the invariable regional gland involvement. The later forms of tuberculosis are practically always metastatic from a glandular focus. The lesion at the point of inoculation is usually slight in extent and shows a marked inclination to healing. The disease may remain latent in the glands, however, for a long period of time and metastasis take place following some injury, whether that be an intercurrent disease, overwork, dissipation, etc.

Phthisis pulmonalis is a bronchogenic metastasis, a true bronchial infarct. This disease is intra-alveolar, pneumonic in type, and as a rule has a bad prognosis, no matter how slight the earlier lesion may be. The first manifestation of phthisis pulmonalis may be quite severe and the patient have a great amount of involvement within a very short time after the pulmonary symptoms have manifested themselves. In other words, the disease does not always begin as "incipient," and then later become moderately advanced and far advanced. It may be far advanced from the very beginning. Extension takes place via the bronchi by aspiration of tuberculous material into unaffected parts of the lung. Phthisis pulmonalis may in rare instances be caused by a re-infection from without.

Another form of bronchogenic metastasis is pleural tuberculosis, in which the metastatic tubercle instead of rupturing into the bronchus, with the discharge of its contents to the outside, ruptures into the pleura with resulting pleural disease.

Miliary tuberculosis, whether it be general miliary or only partial miliary, with local manifestations in joints, bones, kidneys, etc., is a hematogenous metastasis which very often comes from a diseased bronchial gland. The result of such a miliary tuberculosis depends upon the number of organisms getting into the

circulation, as well as the "resistance" of the individual. When the lungs are also involved in a general miliary tuberculosis the roentgenogram is the best diagnostic means we have at present.

Still another form of tuberculous disease is one which is rather uncommon and has a fairly good prognosis. This is caused by an extension of the disease by continuity from the glandular focus along the lymph channels. It is interstitial in type, running a slow course and responding usually more readily to treatment than phthisis pulmonalis. Roentgenologically one fails to see the cloudy shadows of the tuberculous bronchopneumonia in this type of disease.

The author's paper was based on the roentgenographic study of 700 cases, with all forms of tuberculosis, and clinical observations on 3,000 such cases.

LILIENTHAL, HOWARD. The Relation of Roentgenography to the Diagnosis and Therapy of Non-Tuberculous Diseases of the Lungs and Pleura. (*Med. Red.*, Vol. 91, No. 14, April 7, 1917, p. 587.)

The more Dr. Lilienthal has made use of the roentgen ray in thoracic surgery, the more convinced he has become of its usefulness and indispensability, and in the present paper he proceeds to sketch in a brief though pointed way the advantages he has derived therefrom in a number of serious conditions. Thus, in purulent pleurisies he has but rarely been misled by the roentgen findings and he considers the latter so important that he examines the plates in every case of suspected empyema and advises against diagnostic puncture until the patient is actually on the operating table, when the puncture can at once be followed up by the operation.

Furthermore, the roentgenogram has saved him several times from opening through a sacculated empyema into the clean pleural cavity with the result of having to do only one operation instead of two and obviating a considerable risk to the patient. His present method of operating for empyema, which Dr. Lilienthal describes with some detail, is only possible with the aid of roentgenography. It enables him to localize the pus and, instead of resorting to the intercostal method, he resects two or more ribs, usually together with the periosteum and, opening the cavity, treats it as an abscess, first packing with gauze and later draining as necessity arises. This selective surgery, which replaces the blind thoracotomy, would be quite impossible without the guidance of the roentgenogram.

Lilienthal has on several occasions seen an encapsulated empyema mistaken for a general one by experienced diagnosticians, when the taking of the roentgenograms was responsible for the substitution of a small and comparatively harmless operation for a greater and more perilous one.

Aided by the roentgen ray, the author has on three occasions freely incised the dangerous area in front and adjacent to the anterior mediastinum next to the heart, when operating for secondary pus collections. According to the older methods, even with the physical signs present, the operation would have to be postponed until pus had been discovered by an exploratory puncture, running perhaps through healthy pleura or even through the lung.

The author also mentions the interesting fact that he has had seven patients suffering from a loathsome, non-tuberculous pulmonary suppuration, four of whom were completely cured by radical surgery. As he explains, this is a new field which could only have been opened up with the help of roentgenography. In conclusion the author calls attention to the importance of correct interpretation of the roentgenograms, describing the information obtained thereby as uncanny in its import and correctness.

PACKARD, MAURICE. Primary Malignant Neoplasm of the Lung. (*Am. Jour. Med. Sciences*, Sept., 1917, p. 351.)

This paper deals with the diagnosis of primary neoplasms of the lung and more particularly with the differential diagnosis of the affection from other pathological conditions. So far as the employment of the roentgen rays is concerned, the author's experience may be summed up as follows:

The roentgen rays may be of little use in differentiating between aneurysm and cancer, although in the diagnosis of cancer pure and

simple they are of great service. Echinococcus cyst of the lung may be differentiated from cancer by the complement fixation test, but roentgenography is of considerable value in differentiating between these two conditions.

Roentgenology has considerably furthered the diagnosis of tumors of the lung. It is of considerable value in determining the origin and mode of extension. The commonest form seen by roentgenographers occurs in the upper lobe, where they produce an intense uniform shadow. This shadow does not quite reach the apex and it may be difficult to distinguish it from other forms of infiltration. Other infiltrating growths may extend from either hilus into the lung field, often merging with the diaphragm. Here fluoroscopic examinations in various positions will often differentiate t ese shadows from pleural effusions and tuberculous nodes by the density and sharp contours.

WATERS, C. A., BAYNE-JONES, S., AND ROWNTREE, L. G. Roentgenography of the Lungs. (*The Archives of Internal Medicine*, Vol. 19, No. 4, April, 1917, p. 538.)

This is a report on roentgen studies in living animals (dogs) after intratracheal injection of iodoform emulsion.

A method is described by which shadows cast by the air passages of the lungs may be unequivocally defined in roentgenograms. This method consists of injecting into the trachea a 10 per cent suspension of iodoform in olive oil, which renders the air passages opaque to the roentgen ray. The limit of a safe dose of this emulsion for dogs is found to be approximately 4 c.c. per kilogram of body weight. The plates are made by an instantaneous exposure by a soft vacuum tube placed above the animal (20 to 30 inches above the plate). As similar suspensions of iodoform in oil have been used in the local therapy of human pulmonary diseases, it is hoped that perfection of the method may ultimately permit its application to man. This preliminary study is the basis of the belief of the authors that by such a method it may become possible to define with precision many roentgen shadows which are at present largely data for speculation.

WEBER, F. PARKES. Acquired Syphilis of the Lungs. (*Proc. Royal Soc. Med.*, Sec. of Med., Nov. 28, 1916.)

After describing six cases of chronic non-tuberculous disease of the lung, three of which he regarded as syphilitic and three as probably of the same nature, Dr. Weber said that while he was physician to the Mount Vernon Hospital for Diseases of the Chest he practically never saw a case which he could regard as one of pulmonary syphilis, but recently he had met with several in which he believed that that diagnosis could be made with more or less probability. In one of these, that of a man, the nature of the lesion had been suggested by a patch of syphilitic leucoderma on the neck, an eruption very rare in men. Many writers on the subject had had the opportunity of making post-mortem examinations. The chief pathologico-anatomical features were: (1) gummatous formation, with a tendency to necrotic changes; and (2) more chronic, and often widely-spread, fibrotic changes, tending to become associated with bronchiectatic dilatations. In the cases now described he thought the changes were chiefly of the fibrotic order, though gummatous formation might also have occurred, especially in two of them.

According to T. Tanaka (Beitrag zur Kenntniss der Lungensyphilis beim Erwachsenen, zugleich über sogenannte muskuläre Lungencirrhose, *Virchow's Archiv*, Berlin, 1912, ccviii, 429) the histology of the pulmonary indurative changes of acquired syphilis was very similar to that of the so-called "white pneumonia" of congenital syphilis. The most characteristic features were endarteritis obliterans, together with peri-arteritis and endophlebitis. Mesarteritis also occurred, and in three cases Tanaka found a noteworthy increase of the unstriped muscle tissue, which he regarded as derived from the walls of the small bronchi, and which had till then never been described as connected with pulmonary syphilis. In regard to clinical diagnosis the question of there being an aortic aneurysm or mediastinal new growth might arise, especially if the left recurrent laryngeal nerve were paralyzed. But the clinical differentiation from tuberculosis was the chief difficulty, for in tertiary syphilitic diseases of the lungs there might be pyrexia, the so-called "tertiary syphilitic fever," such as not very rarely occurred in tertiary syphilitic

disease of the liver, or a complicating fever, due to associated bronchitic and bronchiectatic changes with purulent discharge. Moreover, there might also be (though less in frequency and degree than in tuberculosis) night sweats, emaciation, hemoptysis, and copious mucopurulent sputum. (In some cases of hemoptysis many spirochetes had, he believed, been found in the sputum, though doubtless not the spirochæta pallida of syphilis.) In pulmonary syphilis, however, the lower parts of the lungs were generally chiefly involved, and the absence of tubercle bacilli in the sputum on frequently repeated examinations, together with a history of past syphilis, evidence of tertiary syphilitic lesions elsewhere, and a positive Wassermann reaction ought to turn one's attention in the right direction. In regard to pulmonary syphilis, one had to bear in mind the possible coexistence of syphilitic ulcers or stenoses in the bronchial tubes, trachea, or larynx. Stengel (1903) pointed out that one of the most suspicious symptoms was intense dyspnea of more or less spasmodic type, with a tendency to stridor and cyanosis, all of these being indicative of obstruction in the larger air passages. In some cases the respiratory symptoms were altogether much more severe than the ordinary physical signs in the lungs would lead one to suppose. There might also be recurrent severe spasmodic attacks of coughing, accompanied by more or less copious mucopurulent expectoration. In some cases pleurisy and pleuritic effusion might be associated with pulmonary (gummatous) syphilis, as they probably were in one of his cases. The therapeutic test was always of some importance, especially when the patient was found to derive obvious benefit from the use of potassium iodide, a drug which sometimes aggravated the symptoms in pulmonary tuberculosis. Old cicatricial stenoses of the respiratory passages could not, of course, be removed by antisyphilitic treatment. It must always be remembered that pulmonary tuberculosis was not at all rare in syphilitic subjects, and, vice versa, that tuberculous patients not very rarely acquired syphilis. He did not think that the two diseases had much effect, either good or bad, one on the course of the other, unless one or both of them had been sufficiently severe to produce a condition of cachexia and to lower the resistance of the body towards disease. Pulmonary tuberculosis, as far as he could judge, was uninfluenced by the presence of an old quiescent syphilitic taint. Though by some an antagonism between the two diseases had been supposed to exist, it was more probable that syphilis predisposed to tuberculosis, in so far as it lowered the vitality of the organism; and it was not unlikely that syphilitic tissues, as had been maintained, constituted a specially favorable soil for the growth and multiplication within the body of tubercle bacilli. When the tuberculosis was active and the syphilis quiescent or obsolete, the former naturally dominated the whole clinical aspect and the prognosis, and the effect of energetic antisyphilitic treatment by mercury and potassium iodide was not unlikely to be a bad one. Though salvarsan and neo-salvarsan in moderate doses seemed to do no harm in ordinary cases of pulmonary tuberculosis, yet, as far as he knew, they did no good.

ECKFORD, W. H. Early Diagnosis of Pulmonary Tuberculosis by the Use of the *X*-Rayed Guinea Pig. (*J. Lab. & Clin. M.*, Vol. III, No. 3, December, 1917, p. 175.)

The chief objections to the inoculation method in the diagnosis of early or obscure pulmonary tuberculosis are that the positive virus requires a long time to develop in the inoculated animal, and that some animals have sufficient natural resistance to overcome a mild infection. For these reasons any means of effectively breaking an animal's resistance so that the length of time is decreased and the "take" made more certain is worthy of a thorough trial.

Murphy and Ellis showed that white mice were remarkably more susceptible to bovine tuberculosis after having been exposed to the roentgen ray than were normal animals. They offered as an explanation the destruction of the lymphoid tissue which they cited as an important factor in the defensive mechanism against tuberculosis. Morton, assuming that the guinea pig would be affected in a like manner, tried the roentgen ray on a series of inoculations. He reported that when animals were subjected to a massive dose of roentgen ray about the time of inoculation, they were so sensitized as to reduce the time of development of recognizable lesions to ten days. He intimated that repeated exposures might be more effective but were unnecessary. He found

marked reductions in the leucocyte counts following the exposure.

Haythorn and Lacy, while carrying out some studies in the healing process of tuberculous lesions treated by the roentgen ray, noted the continued fall in the resistance and the rapid extension of the lesions under frequently repeated large doses of roentgen ray. Their findings confirmed the decrease in the total number of leucocytes after a large dose of roentgen ray, but they did not find the decrease in the lymphocytes as described by Murphy and Ellis. They suggested that the well-known inhibiting influence of roentgen ray on the glands of internal secretion might be in a measure responsible for the decreased resistance of the animal.

With the idea of working out a practical routine procedure for sensitizing guinea pigs in the rapid diagnosis of tuberculosis by means of the inoculation method a small group of animals, weighing as nearly 260 grams each as it was possible to get, were inoculated with a uniform dose of tubercle bacilli and given different doses of roentgen ray at varying intervals. The uniform dose of tubercle bacilli was obtained by adding a few loops of tubercle bacilli from a culture of human bacillus tuberculosis to normal salt and placing the mixture in a vaccine bottle containing glass beads and shaking them for one hour in an electric shaker. An equal amount of 20 per cent India ink in normal salt was added and one-half cubic centimeter of the suspension injected into both the groin and the peritoneal sac of each of the animals. As the whole group was inoculated from the same suspension, each animal received approximately the same dose of the tubercle bacilli. The dose of roentgen ray was given with a Coolidge tube. The current was 60,000 volts, spark gap six inches; filter one half millimeter of aluminum; target twelve inches; length of time five minutes. The animals were examined each day and the effects on general condition, time of appearance of nodules, progress of lesions, etc., were noted. Leucocyte and differential counts were made regularly.

The Singer Laboratory, Pittsburgh, has, since the use of the roentgen ray for the purpose of sensitizing animals was begun, the records of fifty-six animals that have been inoculated either with known tuberculous or suspected tuberculous material. In several instances material from a patient has been injected into two animals at the same time, one animal being subjected to roentgen ray while the other was not. In one such instance both animals showed lesions on the same day, but the rayed nodule outstripped the other in the rapidity of development. In another instance the roentgen ray was not used until several days after the inoculation, and no nodules had appeared at the time its use was begun. Doses were then given on alternate days and after the second exposure a nodule appeared and developed rapidly.

Throughout the work it was obvious that the rapidity of appearance and development of the nodules depended more on the size of the dose of tubercle bacilli than upon the amount of roentgen ray given.

Based largely upon the above findings the following routine method for using roentgen rayed guinea pigs in the early diagnosis of tuberculosis is recommended.

The material must first be prepared for injection. If it is sputum or is of a mucoid nature, it is subjected to fifteen minutes' digestion with 4 per cent potassium hydroxide after Petroff's method and is centrifuged and washed before injection. If it is of a fibrinous nature, it is digested in 15 per cent antiformin, the length of time depending upon the resistance of the material to digestion. If it is a clear fluid, it is merely centrifuged and the sediment taken. From one-half to one cubic centimeter of the prepared material is injected into both the groin and the abdomen of the animal, which is then exposed every second day to a five minute dose of roentgen ray for at least three exposures. If a nodule has appeared and is still present in two weeks, it is removed under a local anesthetic, smeared, and examined histologically. If positive, it is reported at once; if negative, the animal should be kept for at least six weeks so that in case a few bacilli are present in the cavity they may develop independently from the node in the groin. If the animal is negative and a thoroughly "rayed pig" at the end of six weeks the test may safely be called "negative."

FINZI, N. S. Skin Ink. (*Arch. Radiol. & Electroth.*, July, 1917.)

During extensive search for a means of marking skin localization in such a manner that the marks will be indelible and proof against rough treatment, the author made a number

of experiments which finally brought out the following formula:

Acid pyrogallic	1 gram
Acetone	10 c.c.
Liquor ferri perchlor. fort.	2 c.c.
Sp. vini meth.....ad	20 c.c.

This solution meets all the requirements demanded of such a substance.

1. It stains the skin such a color that it will show up against iodine.
2. The mark is unaffected when rubbed with spirit, acetone, ether, soap or tincture of iodine.
3. The mark lasts when covered up with dressings, at least five days, and longer.
4. The mark is quickly and easily made, and does not hurt the patient when placed on a part that is acutely inflamed and tender.
5. The substance used for the mark does not damage or inflame the skin.
6. It is possible to see the mark immediately it is made.
7. The materials are easily obtainable.

The solution is best kept in a bottle with a camel's-hair brush attached to the cork so that it can be easily painted on. The mark is brownish gray at first but after a few hours turns a brilliant black.

COLE, L. G., AND HOGUET, J. P. A. A Complication of Gastric Ulcer. (*N. Y. Med. Jour.*, Vol. CV, No. 13, March 31, 1917, p. 588.)

An interesting case, illustrated by four excellent roentgenograms, is described by the authors which had variously been diagnosed as gastritis and appendicitis in previous treatments. The patient was an unmarried woman of 26, very constipated and anemic. She had lost about twenty pounds in the last year. There had been periodical attacks of pain between the shoulders and in the epigastrium, of vomiting and pain after eating. When referred to the authors, Dr. Cole's roentgenograms ruled out gastric carcinoma but disclosed a minute punctate ulcer, surrounded by a small indurated area, on the lesser curvature about four inches from the pylorus. Furthermore, there was definite evidence of a veil or membrane involving the cecum and ascending colon. Incompetency of the ileocecal valve was demonstrated, admitting as it did of moderate regurgitation.

Operation confirmed these findings and the pathological report showed chronic ulceration of the gastric mucosa with chronic inflammatory changes which were extensive in the deeper layers and less so in the dilated appendix.

About three months after the operation a barium clysma passed back to the cecum. Another three months later, the lesser curvature at the site of the ulcer was absolutely smooth and the only roentgenological evidence of the original complaint was a slightly altered depth in the peristalsis in this region.

The importance of the case lies in the fact that it illustrates a complication of gastric ulcer which the authors consider a clinical entity which has previously been more or less overlooked. In their opinion it may throw some light on intestinal toxemia and autointoxication, and possibly on the etiology of gastric and duodenal ulcers inasmuch as the ileocecal valve ceased to exist and the intestinal contents were consequently regurgitated into the small intestine.

CUNNINGHAM, WILLIAM P. Dermatological Aspects of Chronic Intestinal Stasis. (*Am. Med.*, Vol. XII, No. 4, Ap., 1917, p. 225.)

Cunningham is a staunch advocate of the radical Lane therapy for chronic intestinal stasis. He not only subscribes to all the distinguished British surgeon says in holding stasis responsible for a vast number of direct and remote physical ills but suggests, with all the appearance of firm conviction, that most, if not all, skin eruptions—notably the intractable ones—are due to intestinal stasis. He details a large number of these complaints, including alopecia, and in a roundabout way traces them directly or indirectly to improper intestinal function. Consequently he assails the principle of external local medication, dilates upon the futility of internal medication in these cases, and wants to see the evil eradicated by the root—the intestines. He does not demand in precise terms a typical short-circuiting operation for every pimple in the face but he asks the question: "Is it possible that we should ever advise laparotomy for such a trivial thing as acne? Is acne such a trivial affliction?" And

he furnishes the answer: "Many times, yes; many times, no."

In hyperidrosis he advises at least to resort to roentgenography to settle any doubt whether the intestines are at the bottom of the "cess-pool," and probably he would not object to this method being invoked before he decided to anastomose the ileum with the rectum in order to grow hair on a bald head. So there is hope for a fair expansion of the roentgenologist's occupation.

DIXON, GEORGE SLOAN. Roentgenography of the Eye and Orbit. (*New York State Jour. Med.*, Vol. XVII, No. 2, Feb., 1917, p. 67.)

In an article which once more calls attention to his apparatus for the location of foreign bodies in the eye, as last described by John E. Weeks in his textbook on "Diseases of the Eye," Dixon gives an interesting survey over the possibilities of foreign bodies entering the various parts of the eye. He strongly advocates a roentgen examination in every accident case in which the eye is involved, and believes it would astonish those not in the habit of employing this method of examination as routine to learn of the frequency with which foreign bodies are found where nearly every other diagnostic point is against it. In the author's experience the smallest particles of iron or steel, lead, copper or brass, in fact all metals except small pieces of aluminum, can easily be shown and there is no excuse for missing them. Stones and glass are also easily shown, but small or even moderately large pieces of wood can not be detected unless they happen to be painted. Lead and iron always yield strong shadows no matter how small they are, but glass throws a weak shadow, so that in a search for the latter substance the tube should be much lower than one used for iron. Calcareous degeneration of the crystalline lens and bone deposits in the choroid are clearly shown.

A single plate should never be wholly relied upon, as a defect in the plate might simulate a foreign body which would not appear on a second plate. Again, certain objects might cast a shadow in one direction and not in another. Failure to find a wound of entrance is no proof that the globe does not harbor a foreign body. Siderosis should not be overlooked as a possible evidence of the presence of a particle of iron.

The statements of patients can not always be relied upon, although they should be taken into consideration. Thus, cataract in a young individual may be found to be due to a foreign body, while the patient may be wholly unconscious of any accident responsible for its presence.

Failure to secure a shadow is no proof of absence. On the other hand, an object of fair intensity and good form may be simulated on the plate, while the picture may be only the shadow of iron rust. Other possibilities of failure to visualize foreign bodies are explained, including non-observance of the necessity of fixing the vision during exposure.

The author explains that in his long experience at the New York Eye and Ear Infirmary and other practice he has not been able to show intraocular tumors by means of the roentgen ray, while a fair idea of the size and location of orbital tumors can be obtained.

In summing up, the author feels sure that if the ophthalmic surgeon would obtain the best results, it is imperative for him to have recourse to the roentgen ray in the majority of cases, and that with better technic it may perhaps soon be possible to obtain information involving the optic foramina which is now largely conjectural.

DAVEY, WHEELER P. The Effect of X-Rays on the Length of Life of Tribolium Confusum. (*Jour. Exp. Zool.*, Vol. 22, No. 3, April 5, 1917, p. 573.)

Numerous experiments have led the author to formulate the following summary of his observations.

1. It has been shown that the lethal effect noticed on tribolium confusum beetles after being subjected to the roentgen rays is really due to the latter and not to some accidental circumstance.

2. A method has been developed which eliminates the error due to idiosyncrasy, thus making it possible to obtain biophysical data of a considerable degree of precision.

3. It has been shown that the lethal effect of the roentgen rays on tribolium confusum bears a definite mathematical relation to the logarithm of the total roentgen dose.

4. An extension of the psychophysic law gives a theoretical explanation of the experimental data, if the resistance rather than the susceptibility of the organism to the rays is considered.

The author promises to take up in a later paper the effects produced by changes in voltage.

FRANK, ROBERT T. Palliative Treatment of Inoperable Carcinoma of the Cervix by Means of Radium. (*Jour. Cancer Research*, Vol. II, No. 1, Jan., 1917, p. 85.)

Frank has found from practical experience in the Gynecological Section of the Mount Sinai Hospital, New York, that radium is the best palliative measure in inoperable carcinoma of the cervix and that far advanced cases may be so treated, with the result that not only pains, hemorrhages and discharges are rapidly relieved, but that the general health and condition are indirectly improved. Borderline or operable cases should be submitted to operation after a short preliminary application of radium and subjected to a similar treatment after operation for prophylactic purposes. The author advises preliminary irradiation extending over a period of three weeks, giving exposures of about, 2,000, 1,200 and 800 milligram hours each, followed within two or three days by hysterectomy. Earlier operation is inadvisable for bacteriological reasons. Four weeks after operation at least three radium treatments at four weeks' interval should be given.

Brass or lead is interposed to filter away the soft alpha and beta rays and produce in their stead soft secondary rays which are as destructive to the tissues as the soft primary rays but are readily absorbed by Para rubber, gauze or paper.

The application is made according to the site and size of the growth and the dimensions of the vagina. The radium tubes employed contained 83, 20, 17 and 10 mg, respectively, and the application was made as follows:

For 47 mg the naked tubes were placed in a hollow lead cup, attached to a handle. The opening was covered with a lid of brass 1 to 1.5 mm thick and fastened with a layer of adhesive plaster. The cup was enclosed in a small bag or rubber 1 mm thick.

For large cauliflower growths the 83 mg tube was enclosed in a brass capsule 1.5 mm thick. If the anterior wall is infiltrated and the rectovaginal septum unaffected, one side of the carrier may be additionally screened by 4 to 8 thicknesses of lead foil inside the rubber filter. Similarly, the rectum may be protected from unnecessary irradiation.

In craterlike carcinoma and extending up into the cervix and involving the parametria, the long central tube was advanced 1 to 2 cm and introduced into the cervix, the three smaller tubes radiating at the same time the vaginal portion and fornices. Unless the carrier is introduced into the cervical canal, a layer of gauze, about 0.5 cm thick, is interposed. The carrier, fastened to the handle, is pushed firmly against the gauze, and the vaginal walls are separated as far as possible from the radium by tight packing with gauze. Patients who suffer pain are given liberal injections of morphine.

An application of 120 mg for 24 hours—which is about the extreme limit of time—gave the large dosage of 2,880 milligram hours, but a considerable part is absorbed by the 1.5 mm of brass or 0.5 mm of lead, the 1 to 3 mm of rubber and the gauze. The frequency of application depends upon individual conditions, but the author has found the following method the most satisfactory. The further advanced the growth, the larger the initial dose; the second treatment to follow 7 to 10 days later and the third, 14 days after the second treatment. With improvement apparent, the next two treatments are given at intervals of three weeks in diminishing dosage. For the first series 5,000 to 6,000 milligram hours are sufficient, and thereafter one treatment each month for two or more months completes the primary treatment.

The author further describes the results of the histological examinations, illustrated by excellent microphotographs. The first cellular changes are noted about ten days after the initial treatment. Rapid surface disintegration set in after three weeks. The maximum depth of the effect of 120 mg of radium upon cancer tissue was 1 to 1.5 cm even after 4 or 5 prolonged exposures. Larger quantities may perhaps exert much deeper effects in the author's opinion, but the optimum amount is generally agreed to be from 50 to 100 mg.

One of the removed uteri was cut in inter-

rupted serial sections, and in only two minute areas were spots discovered suggestive of degenerative carcinoma cells.

In view of these facts the author is led to conclude that some additional local factor must exert a favorable effect. This, in the case of cervical carcinoma, is probably supplied by the large quantity of connective tissue (parametria) which radiates from the cervix and under the influence of the rays contracts, hardens and perhaps proliferates. As a result, the lymphatics and smaller blood-vessels are permanently blocked and the dense scar produces a condition of "starvation" of the growth. The author does not discuss the question of permanent cures, but confines his conclusions to palliative effects as actually observed.

The histories of ten cases are appended.

SHORTEN, J. A. and BARNARD, T. W. The Suppression of Inverse Current in the Discharges from the Secondary Terminals of Induction Coils. (*Arch. Radio. and Electro.*, August, 1917, p. 65.)

The authors, who are roentgenologists to the Colaba War Hospital in Bombay, occupy a space of no less than seventeen pages of text and illustrations in attempting to describe their efforts to eliminate the inverse current trouble and incidentally simplify the use of the Coolidge tube. But in the end the method only tends to create confusion—a contingency it is always wise to avoid. It is devoid of practical value. J. S. S.

PAIS, A. The Influence of Roentgen Rays on Malaria. (*Gazz. d. Osp.*, Milano, October 21, 1917. XVIII, No. 84, p. 1121.)

The author believes that the course of malaria can be essentially modified by roentgen treatment. If the treatment is administered early and in doses sufficiently small, it will induce a mild course, whereas large doses may change the cycle of the fever. The author's theory is that a new generation of parasites show increased virulence under the influence of roentgen ray treatment. Cases of chronic malaria which have been obstinate under ordinary treatment with quinine make an uncomplicated recovery under roentgen ray treatment, and the spleen is reduced to its normal size.

GRAY, A. L. Roentgen Ray Diagnosis of Pyloric Stenosis. (*Va. Med. Semi-Monthly*, April 13, 1917, p. 9.)

The technic adopted by the author in the diagnosis of pyloric stenosis in infants is as nearly as possible as follows:

Administer the opaque material in warm mother's milk, if practicable; if not, in a modified milk corresponding to the age of the child. Avoid overdistention. Observe on the screen or plate the appearance of the stomach immediately following the ingestion of the meal; note carefully whether there are excessive peristaltic movements within the first half hour. Continue the examinations at intervals of one-half to one hour for the first four hours and again, if necessary, in six hours, note the progress and amount of opaque material in the small intestine. By a careful comparison of these factors with the normal, a fairly accurate conclusion may be reached.

Perhaps the most characteristic sign of pyloric stenosis is an unavailing hyperperistalsis. This, however, does not continue indefinitely, but the stomach appears to tire from its unusual effort, and a condition of rest resembling atonicity ensues. After the rest, the attempts at expulsion are repeated. Overdistention will materially impede gastric motility and will correspondingly prolong the normal emptying time. Not more than two-thirds to three-fourths of the estimated normal stomach capacity should be given, and proper allowance made therefor.

Pylorospasm and atonic gastric dilatation are liable to be mistaken roentgenographically for pyloric stenosis. In pylorospasm, the obstruction may be complete while it lasts, but there is apt to be an early escape of a small amount from the stomach before the spasm completely shuts off the passage, and if the observation extends over a considerable time, the spasm will relax, and a comparatively large amount is apt to be extruded at each ejection before the pyloric sphincter again abnormally blocks the passage. The administration of an anti-spasmodic, such as belladonna, or its alkaloid, atropine, will perhaps definitely deter-

mine between spasm and a permanent condition. The entire absence of peristalsis for a prolonged period, with perhaps a slight leakage from the pylorus, would indicate atonic dilatation, and would be determined only by frequent observation at short intervals.

In borderline cases, where the stenosis is incomplete, there will probably be present more or less hyperperistalsis with an extrusion at short intervals of a relatively greatly diminished amount of the stomach contents.

All things considered, the author does not think a roentgenological diagnosis of pyloric stenosis a very difficult matter, and it should always be resorted to in appropriate cases, as it is perhaps the only possible method of determining with accuracy the condition in its partially developed state.

HOLLAND, C. THURSTON. Roentgen Examination of Dysentery. (*Ann. Trop. Med. and Parasit.*, Vol. X, No. 4. Ref. *Lancet*, Vol. CXCII, March 10, 1917, p. 380.)

The first article in this number of the *Annals* is a report on the roentgen examination of dysentery and other cases by Captain Holland who followed in his investigations the method of Glasson, as described in his paper on the localization of dysenteric ulcers by the roentgen ray including the administration of large doses of bismuth subnitrate for at least six days beforehand. The results, however, showed nothing which might not equally well have been seen on plates taken under similar circumstances from non-dysenteric individuals. As the author observes, "bismuth does not adhere to the raw surface of a gastric ulcer, and the diagnosis can not be made from this point of view." This statement he follows up with the question: "Why then should bismuth adhere to ulcers in the lower bowel?"

HIRSCH, SETH I. Roentgen Diagnosis of Bone Tumors. (*American Journal of Electrotherapeutics and Radiology*, Vol. XXXV, No. 3, March, 1917, p. 113.)

This is a very interesting series of well illustrated articles relating to bone tumors and a credit to any journal. The work is didactic and very helpful. A little carelessness is noted in placing the cuts, two of them in the March issue being upside down, but these little criticisms are as nothing compared to the worth of the article. We take this opportunity of complimenting the *American Journal of Electrotherapeutics and Radiology* on its broadened field. It is printed on larger pages and better paper, and the roentgenological aspects of the paper are in every way creditable.

HEWER, E. E. The Direct and Indirect Effect of Roentgen Rays on the Thymus Gland and Reproductive Organs of White Rats. (*Jour. Physiol.*, Vol. L, No. 5, May, 1916. Ref. *Lancet*, Jan. 20, 1917, p. 111.)

As both thymus and reproductive organs are affected by roentgen rays, it was expected that irradiation of one organ might bring some light to the question of its relation to the other organ. Only a few of the author's results can be quoted. Direct irradiation of the thymus does not determine the appearance of Hassall's corpuscles unless the glands are simultaneously treated. Irradiation of the thymus only causes slight degeneration of the male gonads and delay of sexual maturity, but no alteration in the female. As to irradiation of the male gonads, degeneration occurs and the affected cells are set free in the lumen of the tubules by desquamation. Regeneration is possible, depending on the age of the animal and the total dose of roentgen rays. If the spermatogonia are all destroyed, no regeneration can occur. Hassall's corpuscles always appear, but disappear in time. Excessive vascularization of the suprarenal and hypertrophy of the islands of Langerhans sometimes occur. A very weak total dose accelerates sexual development. Irradiation of female gonads shows that young ova are more resistant than older, while the corpora lutea become abnormally vascular and the hypertrophy of the interstitial gland is constant and persists even after apparent regeneration of the ovary.

BOOK REVIEWS

BIRTH FRACTURES AND EPIPHYSEAL DISLOCATIONS. By Edward D. Truesdell, M.D., Assistant Attending Surgeon and Roentgenologist at The Lying-In Hospital; Associate Surgeon at the St. Mary's Free Hospital for Children, New York. Large octavo of 128 pages with 143 illustrations. Price $4.00. Paul B. Hoeber, New York, Publisher, 1917.

In the foreword the author calls attention to the meagerness of the information on the subject available in student text books. In many cases the information is misleading and creates the impression that dislocation of the epiphyses is more common than fracture of the shafts of the long bones, and that fracture, when it does occur, is of the green-stick variety. In the series studied no green-stick fracture has been observed. All fractures have been found not only to be complete, but have been associated with considerable displacement of the fragments. Evidence of dislocation of the cartilaginous epiphyses has been rarely obtained, even when the method of proving its existence has been understood and applied. Several years' experience with many cases has proved that the roentgen examination of the pregnant woman and the new-born child may be made without detrimental consequences. The cases reported were found in a series of over thirty-three thousand deliveries.

In this series, fractures of the vault of the skull have been less frequent than fractures of the humerus, clavicle or femur. The deepest asphyxia, stupor, circulatory disturbances and respiratory irregularities may all be present in the new-born, following violent and protracted labor; and a roentgen examination of the head may reveal the absence of bone injury. Four cases of fissure fracture of the cranial bones have been observed in the new-born child, one with, and three without, displacement of the fragments. In the first two cases, attention was called to the injury by a subperiosteal hæmatoma. No signs of intracranial injury were present and recovery was uncomplicated. The third case also developed a hæmatoma and had no signs of intracranial injury, other than for a very brief period. Case 4, a fissure fracture of the vault, was accompanied by a depression of the fragment. There was present a large hæmatoma which delayed the proposed operation for the elevation of the depressed fragment. After the first few days, there was a spontaneous improvement in the depression of the fragment, so that operation was abandoned. Eight months later, roentgen examination showed that evidences of the birth fracture of the skull had been almost entirely obliterated. The author then shows the roentgen plates of these cases. The serial plates tracing the process of healing are especially instructive.

The humerus is the bone most frequently broken during delivery. Not even the clavicle is so liable to fracture. On account of the fact that fractures of the clavicle are more likely to pass unnoticed, the relative frequency of the two injuries cannot be given with precision. During this investigation thirty-nine fractures of the humerus were observed in thirty-seven infants. Fractures in infants still-born, or dying shortly after delivery, have not been included in this series. Operative or forcible delivery has been the cause of the majority of these fractures. Twenty-four were produced during breech extraction following version, and six occurred during breech extractions in cases of breech presentation. Seven were attributed to difficulty with the arms at the pelvic outlet in vertex presentations; while in two instances the cause of the fracture was never ascertained. The site of the fracture has invariably been at or near the center of the shaft. The line of fracture was transverse in all cases but one. This was probably due to the fact that the force producing the fracture was usually applied directly to the center of the humeral shaft and at right angles to it. In one instance, the line of fracture was somewhat oblique, an element of torsion entering into its production.

Birth fracture of the humerus is accompanied by some degree of deformity in almost all cases. Two types of deformity in the transverse plane were observed in the roentgenograms. The more common was the sharp outward angulation of the fragments of the broken bone; the second (infrequent) was a lateral displacement without angulation, with the fragments parallel but separated. The angular deformities were so

excessive in some instances as to be almost sensational. Often the unsatisfactory condition of the fragments was not suspected until seen in the roentgenogram. When lateral views were made, it was found that while displacement in the anteroposterior plane was less common than in the transverse, it did occur. An anterior angular deformity was found in some cases. Rotation of the lower fragments outward was also seen when the treatment of the broken bone had been neglected or was inadequately carried out. Over-riding of the fragments was unusual as compared with fractures of the femur, but was considerable in one case. Accompanying every case of birth fracture of the humerus, there has been observed some degree of musculospiral nerve paralysis, indicated by a distinct wrist drop. In cases dissected at autopsy there was no gross lesion of the nerve. The paralysis must be of traumatic origin, due either to the violence producing the fracture, or to bruising of the nerve by the ragged bone ends. The duration of the wrist-drop may be short, disappearing entirely in the first week, or it may persist for six or even eight weeks. In no case has it failed to clear up. An Erb's paralysis of the same arm has been associated with a fracture of the humerus in three cases. This is a more serious injury than the fracture. In the treatment of birth fractures of the humerus, it has been found that the simplest method is the best. These fractures are put up without splints of any sort, the arm being bandaged to the chest wall. The arm is roentgenographed through the dressing to learn the position of the fragments, and the dressing adjusted as necessary. If but a single roentgen observation can be made during the treatment of these fractures, this will be found of the greatest service at the end of the two weeks. At this time it is possible to correct deformities when noted. Deformity after firm union is not of such importance in cases of birth fracture of the humerus as in cases of fracture of the femur. Three-quarters of all cases of fracture of the humerus have shown some deformity at the end of the first month. In a few cases the external angular deformity has been excessive. These cases of residual deformity have been roentgenographed at intervals until the deformities have disappeared. The serial roentgenograms have shown in every case a progressive elimination of the deformity. Nature has been able to restore the bone to a condition that compares favorably with the uninjured humerus. Nature's ability to accomplish this is remarkable.

Between twenty-five and thirty cases of birth fracture of the clavicle have been observed. Because they have not presented so much of interest, they have not been followed so closely. The majority have been produced by more or less difficult breech extraction. The site of the fracture has been regularly near the center of the bone, the line of fracture nearly transverse. In no case has a so-called green-stick fracture been observed. These conditions of fractures of the humerus and clavicles are thoroughly demonstrated by reproductions of roentgenograms. The serial plates of birth fracture of the humerus are a most excellent demonstration of the marvelous ability of nature to restore the deformed bone to the normal condition.

During a period of six years, only thirteen cases of birth fracture of the femur have come under observation. Eight of these were incidental to breech delivery. Three were produced while extracting the child through the uterine incision during Cæsarian section. One was produced by a midwife who swung the new-born child by its leg to induce respiration. In one case, the cause of the fracture was undetermined. The site of the fracture in all cases was near or somewhat above the center of the shaft. In six cases, the line was transverse, in six oblique. One case was roentgenographed too late to show the line of fracture. The most constant deformity was an anterior angulation. There was also often present an external angulation with more or less over-riding of the fragments. Deformities uncorrected have been found to persist long after deformities of corresponding degree, and corrected, have disappeared in cases of birth fracture of the humerus. The anterior angulation is entirely overlooked if lateral views are omitted. The disinclination on the part of nature to compensate for deficiencies of treatment throws added responsibility upon the surgeon. The treatment presents many difficulties. Too much care cannot be devoted to the correction of the anterior displacement. A box splint has been evolved which provides flexion of the thigh, abduction of the leg, such traction as may be required, and the prevention of rotation. The opportunity for cleanliness is provided, and transportation of the infant is easily brought about. A large series of roentgenograms is presented,

showing a most careful study of these fractures. Serial plates showing success and failure with different types of splints are especially valuable.

Dislocations of the epiphyses are more often suspected than proven to exist in the newborn. The opportunity for operative confirmation of these injuries is rare, while autopsies performed on infants still-born do not customarily include an examination of the extremities. Nor does the roentgen examination offer such direct assistance in the diagnosis of these conditions as might be hoped for, since those of the cartilaginous epiphyses, lacking a nucleus of bone within their substance at birth, do not reveal their whereabouts with precision in the roentgenogram. This nucleus is regularly present in the femoral epiphysis and is frequently present in the upper humeral epiphysis. One case of dislocation of the lower femoral epiphysis has been discovered. This was a case of breech extraction in which difficulty was had in delivering the aftercoming head. Roentgen observations, made up to the end of the seventh month, demonstrated that nature had largely restored the injured member to normal. Diagnosis of backward dislocation of the lower humeral epiphysis cannot be made earlier than the end of the first week of life. Four cases of such dislocation have been observed. These all occurred in cases of breech extraction where the arms were extended above the after-coming head. There was considerable difficulty in early roentgen diagnosis. However, by the twelfth day, roentgen confirmation of the injury should be obtainable. The roentgen diagnosis of birth dislocation of the upper humeral epiphysis was definitely made in one case. The plates reproduced show the roentgen evidence of dislocation of the lower femoral epiphysis. Serial plates show nature's repair of the injury by the formation of a new lower femoral shaft and the absorption of the old shaft. Several plates of dislocation of the lower humeral epiphysis are also shown.

The book is printed on a high quality of paper and the prints made from the roentgen plates are excellent. The volume does credit to the publisher as well as to the author. J. B. J.

FRACTURES OF THE LOWER EXTREMITY OR BASE OF THE RADIUS. By LEWIS STEPHEN PILCHER, A.M., M.D., LL.D. Consulting Surgeon Bushwick, German, Jewish, St. John's and Bethany Deaconess Hospitals, Norwegian Deaconess Home and Hospital, New York Skin and Cancer Hospital, Editor of the *Annals of Surgery*. 132 illustrations. Published by J. B. Lippincott & Co., Philadelphia.

This short essay by Pilcher appears to be more the autobiographical sketch of his interest in this common wrist injury than a serious attempt to clarify and instruct. The major portion of this small book is taken up by a detailed description of certain dissecting room experiments. When one reads down to the last few pages and finds so little upon diagnosis and treatment and practically nothing upon prognosis, there is naturally some disappointment, although there is some consolation to the roentgenologist when he finds Pilcher acknowledging that "the final authority as to the character and extent of the injury is the *x*-ray, and resort to it should be made whenever practical both to confirm and correct the diagnosis and later to demonstrate the degree to which proper reposition of the fragments has been secured."

There is some fault to be found with the author's assertion that he "has rarely felt any need of such (general) anesthesia in dealing with a recent fracture of the wrist." Quite to the contrary; if inquiry is made in the cases which show bad results, it will generally be found that no anesthetic was administered to permit a proper manipulation.

It is to be regretted that the author has not undertaken to include more information upon the interpretation of the many roentgenograms which he displays with regard to diagnosis and prognosis. However, both surgeons and roentgenologists will find this volume worth while. It has a distinct value in giving us the opinions of its distinguished author on the old Colles' fracture of our student days.

E. H. S.